0000070474

ARIZONA WATER COMPANY

Docket No. W-1445A-02-0619

2002 RATE HEARING EXHIBIT NO. ___

For Test Year Ending 12/31/01

PREPARED

REBUTTAL TESTIMONY & EXHIBITS

OF

Thomas M. Zepp

EXHIBIT

A-5

Admitted

EXHIBITS

FENNEMORE CRAIG
A Professional Corporation
Norman D. James (No. 006901)
Jay L. Shapiro (No. 014650)
3003 North Central Avenue
Suite 2600
Phoenix, Arizona 85012-2913
Telephone: (602) 916-5000

Attorneys for Arizona Water Company

BEFORE THE ARIZONA CORPORATION COMMISSION

IN THE MATTER OF THE APPLICATION OF ARIZONA WATER COMPANY, AN ARIZONA CORPORATION, FOR ADJUSTMENTS TO ITS RATES AND CHARGES FOR UTILITY SERVICE FURNISHED BY ITS NORTHERN GROUP AND FOR CERTAIN RELATED APPROVALS.	Docket No. W-01445A-02-0619

REBUTTAL TESTIMONY OF THOMAS M. ZEPP

Table of Contents

I. INTRODUCTION, SUMMARY AND CONCLUSIONS

Q. PLEASE STATE YOUR NAME.

A. Thomas M. Zepp.

Q. DID YOU PREPARE DIRECT TESTIMONY ON BEHALF OF ARIZONA WATER IN THIS CASE?

A. Yes.

Q. WHAT IS THE PURPOSE OF THIS TESTIMONY?

A. Arizona Water Company ("Arizona Water" or "the Company") asked me to update my testimony and to review and to respond where I thought it to be appropriate to the July 8, 2003 testimonies of Mr. Joel M. Reiker on behalf of the Arizona Corporation Commission Staff and Mr. William A. Rigsby on behalf of the Residential Utility Consumer Office ("RUCO").

Q. HOW IS YOUR TESTIMONY ORGANIZED?

A. In this section of my testimony, I summarize my conclusions. In Section II, I present an update of my direct testimony. In making my updates I respond to some of the comments Mr. Reiker and Mr. Rigsby made about the approaches and samples I adopted to make those estimates. In Section III, I respond to Mr. Reiker and Mr. Rigsby's contention that smaller water utilities do not have higher equity costs than larger water utilities. As part of that discussion, I present my article that is forthcoming in *The Quarterly Review of Economics and Finance* that addresses this issue. Given the various systematic risks faced by Arizona Water, I conclude the Company requires a 100 to 150 basis point risk premium above benchmark equity cost estimates made with data for the publicly-traded utilities. In Section IV, I respond to Mr. Reiker and Mr. Rigsby's equity cost estimates made with the capital asset pricing model ("CAPM"). I restate their analyses using long-term Treasury rates. In Section V, I comment about the methods Mr. Reiker has taken to make DCF equity cost estimates. I restate his constant growth DCF model results with more appropriate growth rates and revise his multi-stage DCF model by incorporating his estimates of intrinsic growth. Finally, I present an average of his restated CAPM and DCF equity cost estimates. In Section VI, I present Mr. Rigsby's DCF equity cost estimates with restated estimates of VS growth. In this section I also present a summary of my restatements of Mr. Reiker and Mr. Rigsby's DCF and CAPM approaches.

Q. DO YOU SPONSOR ANY SCHEDULES AND EXHIBITS TO ACCOMPANY THIS REBUTTAL TESTIMONY?

A. Yes. I have prepared 15 tables, attached at Tab A, that update my testimony; 12 new rebuttal tables, attached at Tab B, that respond to Mr. Reiker and Mr. Rigsby's contentions; and I sponsor 3 exhibits, including my article, attached at Tab C.

Q. PLEASE SUMMARIZE YOUR TESTIMONY.

A. I provide rebuttal testimony to two primary topics: the cost of equity of publicly-traded water utilities and the magnitude of the equity risk premium above that benchmark equity cost estimate that is required to provide Arizona Water a fair rate of return on equity.

Mr. Rigsby and Mr. Reiker make no attempt to estimate the latter. They just take the position that the equity risk premium should be zero. As a threshold observation, such a position makes no sense when Arizona Water has been unable to issue debt at a cost as low as the A-rated and AA-rated water utilities used by Mr. Reiker and Mr. Rigsby to make their benchmark equity cost estimates. Mr. Reiker and Mr. Rigsby simply ignore this obvious and indisputable fact.

I also respond to Mr. Reiker's and Mr. Rigsby's position that size does not matter in the determination of utility risk and required returns. Mr. Reiker and Mr. Rigsby don't take issue with there being a small firm effect for stocks in general --

they just say the small firm effect does not apply to utilities. The primary "evidence" they offer to rebut the need for any premium is an article by Annie Wong. My recently accepted and peer-reviewed article rebuts Wong and shows that the best available evidence indicates there is a small firm effect for utilities as well as stocks in general.

Q. **DO YOU RESPOND TO OTHER CRITICISMS MR. REIKER AND MR. RIGSBY MAKE OF YOUR ESTIMATED 100 TO 150 BASIS POINT RISK PREMIUM FOR ARIZONA WATER?**

A. Yes. One of Mr. Reiker's contentions is that Arizona Water is less risky than the sample water utilities because it has a higher book equity ratio. In making such a statement, he ignores the fact that even though Arizona Water had an above-average common equity ratio when it issued its last debt issue, it nevertheless could not obtain a debt cost as low as the sample water utilities could have obtained at the time of issue. Mr. Reiker overlooks the obvious point that Arizona Water has business risk that overwhelms any risk-reducing benefit of less leverage. To make matters worse, Mr. Reiker gets fascinated with a technical "unlevered" versus "relevered" beta argument that he attempts to apply to Arizona Water. I point out that he fails in such an application because (1) he has no basis to assume (as he does) that Arizona has the same business risk as the sample companies used to determine beta estimates, (2) he uses the wrong measure of equity in applying the formula and (3) worse than the other points, he does not have a market value for Arizona Water that is required to make the calculation. This is a theory that cannot be applied to Arizona Water. It is like trying to force a square peg through a round hole. Since Mr. Reiker has made this totally inappropriate presentation in his testimony, I respond to it.

Mr. Reiker also contends that the only systematic risk of relevance to the determination of the cost of equity is "beta" when that is not the case. I offer a number of responses to him on that point, one of the most telling is that the author of the CAPM, Professor William Sharpe, says empirical research and other theoretical considerations justify consideration of more risks than beta. Obvious systematic risk candidates are distress risk and size that were found by Fama and French. And Arizona Water's risks of having to meet new EPA arsenic requirements and difficulties with obtaining rates that cover costs when there are limited out-of-period adjustments and opposition to automatic adjustment mechanisms to recover power and other operating costs are obvious candidates that fall in the systematic risk categories of "distress" and "size." These risks may well increase Arizona Water's beta (if one could be measured).

I also respond to Mr. Reiker's and Mr. Rigsby's contention that the January Effect and an article discussed by Mr. Rigsby justify ignoring the small firm effect for utilities. I explain why that such theories do not eliminate the need to recognize small size risk for Arizona Water.

Q. DO YOU REPOND TO MR. REIKER AND MR. RIGSBY'S ESTIMATES OF EQUITY COSTS FOR THE BENCHMARK SAMPLES OF WATER UTILITES?

A. Yes. Mr. Reiker and Mr. Rigsby make equity cost estimates for the benchmark water utilities that average 9.2% and 9.18% (9.2%), respectively. Such equity cost estimates – however they were made – lack perspective, perspective about what is a fair rate of return for the benchmark utilities. Rebuttal Table 1 provides that perspective. It shows that the utilities in Mr. Reiker's sample have been authorized ROEs that have averaged 173 basis points higher than the 9.2% rate of return that Mr. Reiker and Mr. Rigsby conclude is "fair". It also shows that those utilities have earned returns that average 144 basis points above the 9.2% recommendation and that Value Line forecasts of rates of returns two years into the future for water utilities in Mr. Rigsby's sample have averaged 170 basis points above the 9.2% ROEs Mr. Reiker and Mr. Rigsby recommend. This perspective in Rebuttal Table 1 shows that whatever the methods being used, whatever the theories being adopted, and whatever the assumptions being made by Mr. Reiker and Mr. Rigsby, the final ROE estimates being produced are nonsense. It is nonsense to claim that ROEs required by these sample utilities are so far below what they are actually making, actually being authorized and what Value Line is forecasting they will earn. Something is amiss. By contrast, my updated equity cost estimates for the benchmark water utilities fall in a range of 10.3% to 11.2% and are reasonable when compared to returns that are actually being made, authorized and forecasted for the publicly-traded water utilities. Also, my restatements of Mr. Reiker's and Mr. Rigsby's equity costs for the benchmark utilities fall in a range of 9.6% to 11.3% and thus also bracket the averages of authorized, earned and forecasted ROEs in Rebuttal Table 1.

Q. WHAT OTHER ISSUES DO YOU ADDRESS?

A. I also respond to the lengthy technical rebuttal of my testimony that Mr. Reiker has presented. While Mr. Reiker is highly critical of my direct testimony (which relied on data obtained in the summer of 2002) and in places has distorted my testimony, his discussion is flawed and ultimately erroneous in a number of significant respects, as I show below. For example, he argues I made an error by using an industry average forecast of growth when a reliable company-specific forecast was not available, but then turns around and uses such an industry forecast in Schedule JMR-6 to prepare his own estimates of growth when there are no reliable forecasts for some utilities. Mr. Reiker wants it both ways. He also claims I relied exclusively on analysts' forecasts of growth when I did not. He mischaracterizes my testimony being at odds with a paper by Professor Gordon when it is not. He takes a small cite from my testimony in a 1999 Oregon case out of context by claiming I advocated the use of dividend per share ("DPS") growth to make growth estimates for the constant growth DCF model when I did not. Mr. Reiker had my testimony and knew I did not propose such an approach. To support his choice of actual interest rates, Mr. Reiker argues that forecasts of interest rates by Blue Chip should not be adopted when his own Chart 4 shows such forecasts have been unbiased. Such forecasts are more relevant for the period when Arizona Water's new tariffs will be in place than are the current rates he adopts in his analyses. Mr. Reiker offered Chart 7 and 8 as rebuttal of my Tables 9 and 10 but compares a different time period to the one I addressed. Mr. Reiker also fabricates a 9% ROE estimate by carefully selecting data for one of the eleven years in my Table 8. Had he looked at all of the data in Table 8, he would have found the table he relied upon to create the fictitious 9% ROE estimate actually supports an ROE range for Arizona Water of 10.9% to 12.0%.

Mr. Reiker also criticizes the estimates I presented in Table 8 that support the small firm effect for water utilities. He chooses the wrong statistics test to increase the calculated uncertainty in my results. This choice of statistical test "allows" him to claim I have not demonstrated the small firm effect for water utilities. I provide a section from a statistics book to show he is wrong and the test he chose was inappropriate.

Q. WHAT ARE YOUR SPECIFIC CONCLUSIONS?

A. My conclusions are:

1. An update of my DCF and risk premium equity cost estimates indicate Arizona Water's cost of equity now falls in a range of 11.3% to 12.7%. See Rebuttal Table 16.

a) Updated DCF equity costs indicate a cost of equity range for Arizona Water of 11.6% to 12.3%.

b) Updated risk premium estimates indicate a cost of equity range for Arizona Water of 11.3% to 12.7%.

2. Appropriate restatements of Mr. Reiker and Mr. Rigsby's equity cost estimates indicate Arizona Water's cost of equity falls in a range of 10.6% to 12.8%. See Rebuttal Table 27.

3. No evidence provided by either Mr. Reiker or Mr. Rigsby shows that the 100 to 150 basis point risk premium I estimated in my direct testimony is inappropriate.

a) Arizona Water's cost for its most recent bond issue by itself justifies a risk premium of 37 to 49 basis points.

b) There is a small firm effect in the utilities industry. The best available evidence indicates Arizona Water's size alone justifies a risk premium adder of 99 basis points. My forthcoming article in *The Quarterly Review of Economics and Finance*, attached at Tab C, shows the Wong article Mr. Reiker and Mr. Rigsby relied upon to dismiss the small firm effect for Arizona Water does not provide a basis for such a dismissal.

c) Arizona Water faces other systematic risks related to changes in EPA requirements to remove arsenic and historical test periods with limited out-of-period adjustments that, combined with the risks mention in a) and b) justifies the 100 to 150 basis point adder.

II. UPDATES OF DIRECT TESTIMONY AND EXHIBITS

Q. HAVE YOU UPDATED THE EQUITY COSTS IN YOUR DIRECT TESTIMONY?

A. Yes.

Q. WHAT IS YOUR UPDATED DCF EQUITY COST FOR THE SAMPLE OF WATER UTILITIES AND ARIZONA WATER?

A. The updated DCF equity cost for the sample of water utilities is 10.8%. In making that estimate I have adopted an average of dividend yields during the three month period ending May 31, 2003. This period of time overlaps the 8-week period Mr. Rigsby adopts to determine dividend yields and contains the spot price adopted by

Mr. Reiker to make his dividend yield estimates. That DCF equity cost estimate is shown on Rebuttal Table 6 and is based on the data presented in Rebuttal Tables 2 through 5. Neither Mr. Rigsby nor Mr. Reiker provide any convincing evidence to reduce the 100 to 150 basis point risk premium adder for Arizona Water that I developed in my direct testimony, thus Arizona Water has an equity cost range of 11.8% to 12.3% based on this updated DCF equity cost estimate.

Q. **WHAT IS YOUR UPDATED EQUITY COST ESTIMATE FOR THE PUBLICLY-TRADED WATER UTILITIES THAT YOU MADE WITH DATA FOR THE GAS UTILITIES?**

A. With the updated data, I estimate the equity cost for the gas utilities sample is 10.6% and Arizona Water's equity cost falls in a range of 11.6% to 12.1%. These equity costs are developed in Rebuttal Tables 8 to 12.

Q. **HAVE YOU UPDATED YOUR RISK PREMIUM ANALYSES?**

A. Yes. Rebuttal Tables 13, 14 and 15 provide updates of Table 22, 23 and 24 in my direct testimony. All of those risk premium equity cost estimates have dropped because the forecasts of Baa rates are now lower than they were last year. Based on the updated risk premium analyses, Arizona Water has an equity cost that now falls in a range of 11.3% to 12.7%. See Rebuttal Table 16.

Q. **DO MR. REIKER AND MR. RIGSBY CRITICIZE YOUR ESTIMATES?**

A. Yes. Both Mr. Reiker and Mr. Rigsby criticize development of my estimate of the 100 to 150 basis point adder to benchmark cost of equity estimates that Arizona Water requires. I respond to their testimony is Section III. Mr. Rigsby provides his own DCF estimates but does not make specific criticisms of mine. Mr. Reiker criticizes (1) the samples of gas and water utilities I used to make benchmark equity cost estimates, (2) the method I used (and Mr. Rigsby used) to compute dividend yields, (3) my estimates of growth used in the constant growth DCF model and (4) my risk premium estimates.

Q. **PLEASE TURN TO MR. REIKER'S COMMENTS ABOUT THE SAMPLES YOU HAVE USED TO COMPUTE DCF EQUITY COSTS. START WITH THE WATER UTILITIES SAMPLE. MR. REIKER CONTENDS YOU SHOULD HAVE INCLUDED CONNECTICUT WATER SERVICE AND MIDDLESEX WATER IN THE SAMPLE USED TO MAKE DCF ESTIMATES FOR THE WATER UTILITIES. WHAT IS YOUR RESPONSE?**

A. I did not include Middlesex Water and Connecticut Water Service in my 2002 sample because their rapid increases in stock prices coupled with low expected growth suggested they were merger candidates. Information for Middlesex Water has changed since last year. Middlesex Water now has an above-average dividend yield of 4% and analysts' forecasts reported by investor services indicate Middlesex Water is expected to have 7% growth. If I had included it in my sample, my average DCF equity cost would be higher than 10.8% because Middlesex Water has an estimated equity cost of 11%. Thus, the rapid growth in Middlesex Water stock prices I observed last year may well reflect the dividend yield and forecasted growth investors expect for it. Mr. Reiker also estimates equity costs for Middlesex Water with his multiple stage growth DCF model (Schedule JMR-6) and finds Middlesex Water has an above average cost of equity. I did not include Middlesex Water in my updated DCF equity cost estimate because it was not in the sample I presented last year.

Q. **WHAT ABOUT CONNECTICUT WATER SERVICE. DOES MR. REIKER EXPLAIN WHY CONNECTICUT WATER SERVICE HAS HAD A 50%**

INCREASE IN ITS STOCK PRICE WHILE STOCK PRICES FOR OTHER WATER UTILITIES INCREASED BY 12%?

A. No, he does not. Connecticut Water Service still appears to be a merger candidate and should not be included in a sample used to make DCF equity costs. At page 32, lines 18-22, Mr. Reiker agrees with me that if investors have bid up a stock price in anticipation of a merger, the DCF method could understate the cost of equity. If such a merger was anticipated for Connecticut Water Service, presumably, Mr. Reiker would not include it in his equity cost estimation sample. The data Mr. Rieker provided in support of Chart 3 at page 33 shows Connecticut Water Service had a price increase of 50% in 2001, the largest price increase of any water company other than American Water Works (a known merger candidate). That price increase compares to an average increase of 12% for the five other water utilities in Mr. Reiker's sample. His Chart 3 shows stock prices for Connecticut Water Service have subsequently moved in line with stock prices for other water utilities. With reasonably efficient markets, even for a thinly-traded stock such as Connecticut Water Service, one should expect information about potential mergers to continue to be embedded in its stock price unless merger rumors disappear. With such a super-inflated stock price, as Mr. Reiker observes, dividend yield and DCF equity cost estimates will be biased downwards. The behavior of Connecticut Water Service stock prices shown in Chart 3 is perfectly consistent with reasonably efficient markets in which investors expected a merger and thus supports my choice to leave it out of the water utilities sample adopted to make equity cost estimates with the DCF model.

Q. **TURN TO MR. REIKER'S COMENTS ABOUT THE SAMPLE YOU USED TO ESTIMATE DCF EQUITY COSTS FOR THE GAS UTILITIES. HE CONTENDS THAT CASCADE NATURAL GAS AND SOUTHWEST GAS**

SHOULD BE INCLUDED IN THE GAS UTILITIES SAMPLE. WHY DID YOU EXCLUDE THEM?

A. I have used the adjusted equity cost estimates for the gas utilities as another proxy for the cost of equity for those water utilities. All of the publicly-traded water utilities (with bond-ratings) that are in my sample of four water utilities and in Mr. Rigsby's sample of three water utilities have a bond rating of A or better. Cascade Natural Gas and SW Gas have bond rating of BBB/Baa and thus are more risky than the sample water utilities. Thus, it is inappropriate to include Cascade Natural Gas and SW Gas in the sample used to estimate equity costs for the lower risk water utilities.

Q. DO YOU HAVE ANY COMMENTS ABOUT MR. REIKER'S GAS UTILITIES SAMPLE?

A. Yes. It is puzzling why Mr. Reiker advocates including those two companies but not including South Jersey Industries. At this time, *C. A. Turner Utilities Reports* indicates South Jersey Industries has a split bond rating of Baa1/A and 80% of its revenues coming from gas operations. This company does meet the relevant criteria, yet has been ignored by Mr. Reiker. I did not include it because last year, when I prepared my direct testimony, *C. A. Turner Utility Reports* indicated that South Jersey Industries had 53% of its revenues from gas operations. I do not include South Jersey Industries in the sample used to make my updated DCF equity cost estimates because it was not in the sample I used to prepare direct testimony.

Q. WHAT IS SHOWN IN REBUTTAL TABLE 7?

A. Rebuttal Table 7 shows beta estimates for the samples of gas and water utilities at the time I prepared my direct testimony and today. To update the gas utilities sample beta I have included South Jersey Industries. There were no differences in average beta estimates when I prepared my direct testimony. However, to be conservative, I assumed the gas utilities required a 50 basis point risk premium when compared to water utilities. The average *Value Line* beta for the updated sample of gas utilities is now higher than it was last year. Below, I discuss potential downward bias in *Value Line* beta estimates for the thinly-traded water utilities. Even if that potential bias is ignored, Rebuttal Table 7 indicates the difference in the required returns for gas and water utilities is very close to the 50 basis points I adopted in my direct testimony and thus I do not revise that 50 basis points in my updated equity costs for the gas utilities.

Q. NOW TURN TO THE ISSUE OF DIVIDEND YIELDS. MR. REIKER ARGUES THAT SPOT PRICES SHOULD BE ADOPTED TO DETERMINE DIVIDEND YIELDS INSTEAD OF AVERAGE YIELDS. WHY DON'T YOU USE SPOT PRICES TO COMPUTE THE DIVIDEND YIELDS?

A. For at least three reasons. First, there are no estimates of "spot" growth rates to combine with the estimates of spot prices. *Value Line*, for example, updates its growth rate forecasts every three months. Other investor services report forecasts of growth rates made by analysts for the last 30 to 120 days. The constraint on the quality of the equity cost estimate comes from the quality of the growth rate estimates, not easily measured dividends and prices. Spot yields provide a false sense of accuracy and should not be used to estimate DCF equity costs. Second, prices for thinly-traded stocks, such as water utilities, are not as efficient as prices for larger stocks. I discuss this further in my discussion of bias in beta estimates. Third, it takes many weeks for analysts to prepare and ultimately present equity cost estimates. Allowing the analyst to choose the "spot" price also allows the analyst to bias his/her estimate of the dividend yield by choosing a price that is higher or lower than other prices he/she could have chosen during the period in which the testimony was prepared. This potential for gaming the equity cost estimate with the "spot" yield is avoided when average yields for a reasonably current period are adopted.

Q. **MR. REIKER RAISES A NUMBER OF ISSUES RELATED TO THE GROWTH RATES YOU ADOPTED TO MAKE YOUR DCF ESTIMATES. AT PAGES 37-39 AND IN FIGURE 1, MR. REIKER ARGUES YOU MADE AN "ERROR" BY USING AN INDUSTRY AVERAGE GROWTH FORECAST FOR UTILITIES WHEN YOU DID NOT HAVE RELIABLE COMPANY-SPECIFIC GROWTH FORECASTS. DO YOU HAVE A RESPONSE?**

A. Yes. His statement is equivalent to "the pot calling the kettle black", i.e., it is a correct method if he does it, but not a correct method when I do it. In Mr. Reiker's own analysis in Schedule JMR-6, his work paper (GrowthCalc, cell H 25) shows he used an industry average forecast (an average of forecasts of DPS growth rates for the water utilities for which he had forecasts) to estimate future dividend growth for Connecticut Water Service, Middlesex Water and SJW Corp when he prepared Schedule JMR-6. If the industry average forecast is the best available information, that industry average forecast is what investors would rely upon to price stocks. Mr. Reiker's testimony at pages 37-39 and Figure 1 should be ignored.

Q. **AT PAGES 39-44, HE CONTENDS YOU RELIED EXCLUSIVELY ON ANALYSTS' FORECASTS OF EPS GROWTH TO PREPARED YOUR DCF EQUITY COST ESTIMATES. DID YOU?**

A. No. Mr. Reiker says I place "exclusive reliance on analysts' forecasts of near-term earnings growth" (page 39, line 9) when I did not. In making all of my DCF equity cost estimates for water and gas utilities in both my direct testimony and rebuttal update of testimony, I relied upon forecasts of sustainable growth (forecasts Mr. Reiker calls "intrinsic growth") as well as analysts' forecasts of EPS growth to make my estimates. He has mischaracterized my testimony.

Q. AT PAGE 40-41, HE DISCUSSES THE GORDON, GORDON AND GOULD PAPER AND A MORE RECENT SPEECH MADE BY PROFESSOR GORDON. IS YOUR TESTIMONY AT ODDS WITH GORDON'S ARTICLE AND SPEECH?

A. No. Again, Mr. Reiker mischaracterizes my testimony. I correctly reported that Gordon, Gordon and Gould ("Choice Among Methods of Estimating Share Yield," *Journal of Portfolio Management (Spring 1989)*) ("GG&G") found that forecasts of EPS growth outperformed three measures of past growth. Such a finding clearly supports the use of EPS growth as one of the measures of growth investors would examine. I never said that GG&G argued for the <u>exclusive</u> use of analysts forecasts to implement the DCF model.

Also, if, as Mr. Reiker suggests should be done at page 41, GNP growth were used to make DCF equity cost estimates with the constant growth DCF model, Mr. Reiker's DCF equity cost estimate for the water utilities shown in Schedule JMR-7 would increase 150 basis points, from 8.5% to 10.0% if his GNP growth forecast from Schedule JMR-6 were used:

Equity cost = 3.47% + 6.5% = 10.0%

Q. DO YOU HAVE ANY COMMENTS ABOUT HIS TESTIMONY AT PAGE 42 TO 44?

A. Yes. I am not surprised that some writers have the view that analysts' forecasts of EPS growth have been too high after the recent stock market bubble burst and seriously damaged portfolios of many investors. It is always easy to look back now and find that the rosy future many believed was just over the hill was not realistic.

As to earlier studies, such as David Dreman's study, I did an analysis of *Value Line* ROE forecasts for gas distribution companies in 1999 and found that contrary to claims such as the one Mr. Reiker reports at page 42, line 4, in real terms (i.e., forecasts adjusted for the difference in expected and actual inflation) the *Value Line* ROE forecasts for gas distribution utilities were unbiased. My analysis showed overstatements in the ROE forecasts were the result of inaccurate forecasts of inflation. Earnings per share forecasts would vary directly with ROE forecasts. Putting one's head in the sand and assuming the past will continue into the future when the future may be much different, however, is not the answer. Investors look forward and they, too, may be making poor forecasts of inflation that are the same as the poor forecasts being relied upon by analysts. But if the analysts and the investors are making the same mistakes, the cost of capital is still revealed by looking at such analysts' EPS forecasts.

Mr. Reiker's anecdotal testimony reported on pages 42 through 44 still provides no basis to assume analysts' forecasts are not relied upon by investors when they price stocks. Had Mr. Reiker read Mr. Dreman's book, he would have seen the author's conclusion supports an inference that investors generally do rely on the analysts' forecasts. Dreman says:

"We have also seen that in spite of high error rates being recognized for decades, neither analysts nor investors who religiously depend on them have altered their methods in any way." (David Dremand, *Contrarian Investment Strategies: The Next Generation.* Simon & Schuster. New York page 115-116.)

If investors depend on the analysts' forecasts – whether the forecasts turn out to be excellent or poor forecasts -- they are relevant to a determination of DCF equity costs.

Q. AT PAGE 45, MR. REIKER PROVIDES TWO QUOTATIONS FROM YOUR TESTIMONY AND DEPOSITION IN UM 903, A 1998-1999 INVESTIGATION INTO AN APPROPRIATE METHOD TO DETERMINE

RECOVERY OF PURCHASED GAS COSTS IN OREGON. DO YOU HAVE ANY COMMENTS ABOUT THE QUOTATIONS HE CITES?

A. Yes, his quotations were very carefully selected to imply I used DPS forecasts to determine equity costs with the constant growth DCF model in a 1999 case, when that is not true. Mr. Reiker has the full testimony and knows that is not the case. He has taken one statement in a deposition out of context and thus misrepresents the analysis I presented in that case. The first cite is to page 9 of my deposition. I have attached the title page and pages 8 through 11 of that deposition at Tab C, labeled as Exhibit TMZ-3, to put the citation in context. Mr. John Thornton, now an employee of the Arizona Corporation Commission, was present and asking the questions at the deposition. He is providing rate design testimony in this case. My testimony (NWN/300/Zepp, dated December 17, 1998) was the subject of the deposition. It was rebuttal of Mr. Thornton's equity cost estimate presented in that case. Exhibit TMZ-3 shows that (1) the quote cited by Mr. Reiker was my second response to a question proposed by Mr. Thornton and it restated the question as Mr. Thornton asked it and (2) my first response referred Mr. Thornton back to my prefiled testimony.

Q. **WHAT DID YOU SAY ABOUT THE USE OF DIVIDEND PER SHARE GROWTH IN THE PREFILED TESTIMONY TO WHICH YOU REFERRED?**

A. I said the following:

Q. **WHAT DO YOU CONCLUDE FROM YOUR EXAMINATION OF PAST AND FORECASTED EPS GROWTH?**

A. Mr. Thornton's selective exclusion of EPS growth from consideration has biased downward his estimate of future DCF growth expected by investors for at least two reasons:

> (1) EPS growth would be considered by investors in determination of future growth. Based on data in Mr. Thornton's work papers and past growth, that consideration would indicate expected growth of 6.5%, 7.8% and 8.6%. All three of these growth rates are above the range of DCF growth rates chosen by Mr. Thornton.
>
> (2) The fact that past and forecasted DPS growth rates are lower than past and forecasted EPS growth rates indicates that investors would expect the LDCs [local gas distribution companies] to be financially stronger in the future. As a result, investors would expect the LDCs to be able to sustain **higher levels of dividend growth in the future than in the past and to achieve higher growth in the long term** than is forecasted for the [near term] period out to 2003. (Emphasis added.)

Oregon PUC, UM 903/AR 245/NW Natural/300, pages 19-20.

Q. IS THE UM 903 TESTIMONY QUOTED BY MR. REIKER CONSISTENT WITH YOUR TESTIMONY IN THIS CASE?

A. Yes, it is. Just as I said in Oregon Docket UM 903, if EPS growth is expected to be more rapid than DPS growth, investors will expect future sustainable growth to be higher than near-term DPS growth. Future DPS growth and historic DPS growth are undoubtedly the worst measures of long-term sustainable growth in such a situation. Those measures of growth would not be relied upon by rational investors making equity cost estimates with the constant growth DCF model. Giving any weight to such DPS growth estimates will bias downward equity cost estimates.

Q. DO YOU HAVE ANY COMMENTS ABOUT MR. REIKER'S CITE AT LINES 11-13 OF PAGE 45?

A. It, too, is taken out of context. The questions and answers starting before and ending after the cite are shown below:

Q. WOULD INVESTORS EXAMINE INFORMATION OTHER THAN BR + VS GROWTH TO DETERMINE THE COST OF EQUITY FACING GAS LDCS?

A. Yes. Investors would examine past and forecasted growth in earnings per share ("EPS"), dividends per share ("DPS") and other trends that provide indications about what future growth would be.

Q. MR. THORNTON BASED HIS GROWTH RATE RANGE OF 3.0% TO 5.0% IN PART ON PAST AND FORECASTED DPS GROWTH. IF INVESTORS WERE TO LOOK AT ONLY EPS OR DPS GROWTH, WHICH ONE WOULD THEY EXAMINE?

A. Available evidence indicates they would look at EPS growth. Investors are willing to pay for compilations of investor analysts' forecasts of EPS growth, such as Standard & Poor's Earnings Guide.

UM 903/ AR245/ NW Natural/ 300, pages 17-18.

This testimony, together with the testimony at UM 903/ AR245/ NW Natural/ 300, page 20 reported above, are totally consistent with my testimony in this case. That testimony is that when forecasts of DPS growth (or past DPS growth) are smaller than expected EPS growth (past EPS growth), reliance on DPS growth as the growth rate in the constant growth DCF model will bias downward the equity cost estimates.

Q. TURN TO YOUR RESPONSE TO MR. REIKER'S CRITICISMS OF YOUR RISK PREMIUM ESTIMATES. AT PAGE 46-47, MR. REIKER ARGUES BLUE CHIP CONSENSUS FORECASTS OF INTEREST RATES SHOULD NOT BE RELIED UPON TO MAKE RISK PREMIUM EQUITY COST ESTIMATES. DO YOU HAVE A RESPONSE?

A. Yes. Mr. Reiker offers Chart 4 to support his recommendation. The data underlying the chart show that in the three years 1999 to 2001, the projected Blue Chip interest rates were lower than actual rates and in the two years 2002 to 2003, projected rates were higher than has occurred. On average the Blue Chip forecasts have been 14 basis points <u>below</u> the rates that have actually occurred.

Interest rates that should be relied upon to determine Arizona Water's cost of equity should be interest rates expected during the period in which new tariffs will be in effect. Relying on "actual" market interest rates in 2003 does not solve the problem of uncertainty about future rates. Actual current Baa rates as well as forecasts of Baa rates, depend upon investors' perceptions of what will happen in the future. As a result, the quotation Mr. Reiker offers at page 47 from Jacob and Pettit cannot be a criticism of my choice to use Blue Chip forecasts of the Baa rates. Mr. Reiker's own Chart 4 shows that to the extent there has been any difference between actual rates and the Blue Chip forecasts of rates, on average, bond rates turned out to be higher than was estimated with the Blue Chip consensus forecasts.

In Mr. Reiker's CAPM testimony, he adopted actual rates instead of forecasts of those rates to make CAPM estimates. But those actual rates are a weighted average of short-term rates in 2003 and rates in the future; thus, those current rates reflect interest rates that exist before the period in which Arizona Water's new tariffs will be established. Based on actual market data on July 30, 2003, the benchmark 10 year Treasury rate (currently 4.38%) is 37 basis points below the forward 10 year Treasury rate expected by investors next year (4.75%). The forward rate is almost a full percentage point (95 basis points) above the 10-year Treasury rate Mr. Reiker relied upon to prepare his equity cost estimates 3.80% (Reiker Direct, footnote 12). Thus, for similar reasons, forecasts of Baa rates are preferred to current Baa rates because they provide estimates of the costs of bonds expected when the new tariffs for Arizona Water will be in place. To the extent that current short-term interest rates are lower than interest rates expected in the future, the use of current Baa rates will understate the relevant cost of equity. Blue Chip forecasts reflect the pure forecast of the rates after the 2003 short-term rates are history. With interest rates at forty year lows, the chance future rates will be higher than today is much better than the chance they will be lower. As a result, the forecasted rates should be adopted.

Q. **MR. REIKER SAYS THE CAPM SHOULD BE USED INSTEAD OF YOUR RISK PREMIUM APPROACHES. DO YOU HAVE ANY RESPONSE TO THAT TESTIMONY?**

A. Yes. My response is in Section IV of my testimony.

Q. **REFERRING TO PAGE 48-49 OF MR. REIKER'S TESTIMONY, DOES THE FACT THAT CORPORATE BONDS MAY HAVE CHANGING DEFAULT RISK PREMIUMS MEAN ONLY TREASURY SECURITIES SHOULD BE USED TO COMPUTE RISK PREMIUM ANALYSES?**

A. Of course not. Such a statement implies equity costs are more closely tied to costs of Treasury securities than to the utilities' own costs of debt. It is more logical to expect equity costs to reflect changes in corporate debt costs than to assume those equity costs move in lockstep with interest rates the government can obtain in the market. This was especially true during the last several years when there was a flight to quality and investors bid up long-term Treasury security prices (and bid down yields) in anticipation that the government would issue fewer Treasury securities. Now that a new huge deficit appears to be emerging, the latter concern may go away and the spread between equity costs and Treasuries rates will change again. Of the two choices, corporate bonds and Treasury securities, logically the corporate bonds are expected to have the more stable risk premium.

Q. **REFERRING TO PAGE 49, ARE THERE GREATER PROBLEMS WITH YOUR RISK PREMIUM APPROACHES THAN THE CAPM IF RISK**

PREMIUMS CHANGE OVER TIME?

A. No. I discuss this issue in section IV. There are greater problems with the CAPM as I explain in Section IV.

Q. SHOULD ANY WEIGHT BE GIVEN TO STAFF'S CONCERNS WITH THE RISK PREMIUM ANALYSIS YOU PRESENTED IN TABLE 22?

A. No. Staff chose to write this testimony instead of asking for my work papers. In response to the specific three points they raise: (1) The water utilities in the CPUC sample are the companies in Mr. Reiker's sample plus American Water Works. (2) The utilities in the CPUC sample are seven of the companies in the list of utilities followed by C. A. Turner Utility Reports. (3) On average, for the period 1991-2000, the seven water utilities earned ROEs that were 48 basis points lower than authorized. Rebuttal Table 17 is the work paper I would have sent to Staff if they had requested it. My estimate of 40 basis points in Table 22 was conservative.

Q. DO YOU HAVE ANY COMMENT ABOUT MR. REIKER'S REBUTTAL OF THE RISK PREMIUM ANALYSIS YOU PRESENTED IN TABLE 23?

A. At lines 2-11 of page 38 of my direct testimony, I have already explained why it is appropriate to consider authorized ROEs as measures of the cost of equity and pointed out the FERC has made such a determination in the past. I do not repeat that testimony again.

Q. DO YOU HAVE ANY COMMENTS ABOUT MR. REIKER'S CRITIQUE OF THE RISK PREMIUM ANALYSIS YOU PRESENTED IN TABLE 24?

A. Yes. Based on the data underlying Chart 6, the current gas utility beta is the same as the average beta over the period shown in Chart 6. I do not agree that beta risk is the only systematic risk that is relevant to investors, but if one limits consideration of risk to Mr. Reiker's measure of risk, Mr. Reiker's Chart 6 supports the use of the risk premium analysis I present in Table 24 and my update of that analysis in Rebuttal Table 15. Based on Mr. Reiker's analysis, beta risk today is the same as it has been, on average, during the period the average risk premium was estimated. Contrary to his statement at page 52, line 10, past risk and returns are relevant if the current beta is relevant.

Q. DO YOU HAVE ANY COMMENT ABOUT HIS TESTIMONY AT PAGE 52-53 AND HIS CHART 7 AND CHART 8?

A. Yes. Mr. Reiker says I said things I did not say. I compared authorized ROEs for Arizona utilities during the period 1997 to 2001 (shown in my Table 10) to interest rates that prevailed during the same period (my Table 9). This comparison showed that in all but the most recent case, the authorized ROEs for Arizona utilities were in a range of 10.5% to 12.0% when the range of interest rates were in a range of 7.32% to 8.37%. As shown in Rebuttal Table 1, such authorized ROEs in Arizona are in line with the ROEs earned and authorized for utilities in Mr. Reiker's sample of publicly traded water utilities. Mr. Reiker argues that interest rates going back to 1967 are of interest when they have nothing to do with the comparison I presented. In the period prior to 1997, equity costs would have been higher when interest rates were higher.

Q. AT THE BOTTOM OF PAGE 53, MR. RIKER CLAIMS YOUR TESTIMONY SUPPORTS AN EQUITY COST OF 9%. HOW DID HE DERIVE THAT FIGURE?

A. He derived a 9% equity return by using one year of data and ignoring the other 10 years of data presented in Table 8 of my direct testimony. The purpose of Table 8 was to provide internally consistent estimates of the differences in costs of equity for large and small water utilities. To make those estimates I relied upon methods the California PUC Staff used in past cases.

In order for Mr. Reiker to fabricate the 9% ROE estimate he presents at the bottom of page 53, he had to carefully select data for one of the 11 years and ignore the other data in the Table 8. See Rebuttal Table 18. If the data in Table 8 are used to compute another risk premium estimate -- as Mr. Reiker suggests -- the appropriate thing to do is use data for all of the years, not just one year. I have done that in Rebuttal Table 18 and compute the average risk premium above Baa bond rates for the larger water utilities to be 2.82%. Combining that estimate with the current forecasted range of Baa rates indicates a cost of equity for the larger water utilities of 9.9% to 10.5%. And, adding in the 100 to 150 basis point risk premium required uniquely by Arizona Water, the implied equity cost for Arizona Water is 10.9% to 12.0%, substantially higher than the 9% estimate he says my testimony would support.

III. <u>SIZE AND OTHER RISKS REQUIRE THAT ARIZONA WATER BE AUTHORIZED AN EQUITY</u>

A. <u>Risk premium of 100 to 150 basis points.</u>

Q. AT PAGE 55-56, MR. REIKER DISCUSSES ARIZONA WATER'S RECENT BOND PLACEMENT. CAN ARIZONA WATER EXPECT TO ISSUES BONDS AT A COST THAT AN A-RATED WATER UTILITY OR AA-RATED WATER UTILITY COULD EXPECT?

A. Absolutely not. The three water utilities with bond ratings that Mr. Rigsby and I adopt to estimate equity costs currently have S&P bond ratings of either AA- or A+. After a 9 month search for someone to buy the issue, when Arizona Water issued its series K bonds, the Company's cost of debt was 37 basis points higher than the cost of A-rated bonds and 49 basis points above the cost of AA-rated bonds at the time the rate on the series K bonds was set.

Q. WHAT IS THE IMPLICATION OF THIS COST OF DEBT WHEN THE COMMISSION DETERMINES ARIZONA WATER'S AUTHORIZED EQUITY RETURN?

A. The implication is that Arizona Water requires a higher equity return than the cost of equity estimated for the A-rated and AA-rated water utilities. Basic finance principles tell us that a utility's cost of equity is higher than its cost of debt. If all water utilities have equity costs that are the same margin above their respective costs of debt, evidence from the series K issue for Arizona Water indicates the Company requires a risk premium that is at least 37 to 49 basis points above the benchmark costs of equity estimated for the water utilities sample. (At the time the series K rate of 8.04% was set, the cost of A-rated utility bonds was 7.67% and the estimated cost of AA utility bonds was 7.55%). Other evidence presented in my direct and this rebuttal show that such a range of equity cost adders is a conservative measure of the premium Arizona Water requires. As discussed in my direct testimony and further below, the full premium falls in the range of the 100 to 150 basis point risk premium I recommend for the Company.

Q. DO YOU HAVE ANY COMMENTS ABOUT MR. REIKER OR MR. RIGSBY'S RESPONSES TO YOUR STATEMENT THAT HISTORICAL TEST YEARS AND OTHER PROCEDURES IN ARIZONA INCREASE ARIZONA WATER'S RISK?

A. Yes. Neither Mr. Reiker (pp. 56-57) nor Mr. Rigsby (pp. 59-62) explain why the risks related to historical test years do not increase one or more systematic risks. Mr. Reiker mentions uncertain consumption; surely, that would increase beta risk because consumption will vary with economic activity. A lack of streamlined procedures, automatic adjustment mechanisms and limited post-test year adjustments would increase the distress systematic risk identified by Fama and French.

Q. MR. REIKER (p. 57) AND MR. RIGSBY (p. 62) CLAIM THAT ARIZONA WATER DOES NOT FACE ADDED RISK BECAUSE OF CHANGES IN EPA REQUIREMENTS YOU ADDRESSED IN YOUR DIRECT TESTIMONY. DO YOU AGREE?

A. No. The new maximum contaminant level established by the Environmental Protection Agency for arsenic in public drinking water will require substantial new investments by Arizona Water as well as much larger annual expenses. Mr. Kennedy discusses these substantial costs in his rebuttal testimony. As I explained in my direct testimony (page 12-13 and15-18), there is no doubt about how such new requirements impact risk. An investor would much prefer to own the lower risk utility that does not have to make such investments or attempt to recover such annual increases in operating costs. This is yet another instance where Mr. Reiker makes cavalier claims based on the original Sharpe-Lintner model. Without any empirical support, he dismisses my testimony by saying such risks are not priced by investors. Common sense tells us that beta risk would be expected to increase as expenses become more uncertain and covariance with the market undoubtedly increases to some extent. Alternatively, added investments and expenses required by the revised EPA requirements may increase another systematic risk, distress risk. Mr. Reiker is apparently unwilling to acknowledge there are other systematic risks such as distress risk. Mr. Rigsby dismisses my statement because there is a pending decision that will establish some sort arsenic recovery mechanism. Such a recovery mechanism – even if ideal – would not eliminate the Company's need to raise capital to pay for the added investments. It is my understanding, however, that the proposed cost recovery mechanism, if approved, would not allow full cost recovery, a situation far from the ideal. And, as a company – particularly a small company like Arizona Water with relatively limited access to financial markets -- has to make above average investments, investors require higher returns. I presented a study I made that found electric utilities with above average investment requirements were more risky than those with below-average investment requirements. (Zepp Direct, page 13) Neither Mr. Reiker nor Mr. Rigsby found fault with that study and neither of them show why it would not be applicable to water utilities that are required to make larger than average investments to meet EPA requirements.

Q. **ARE THERE OTHER CONCERNS RELATED TO THE NEED TO MAKE SUBSTANTIAL NEW INVESTMETNS TO MEET EPA REQUIREMENTS?**

A. Yes. Arizona Water Company must increase its equity position to enable the Company to convince lenders, such as insurance companies, that the Company has sufficient financial strength to borrow more money and pay interest and principle on new bonds. It is unavoidable that new debt will be needed to fund the additional investment in plant to deal with the new arsenic standard. Arguments such as Mr. Reiker and Mr. Rigsby present would penalize the Company for attempting to improve its financial strength. The Company should not be penalized for proper planning for future needs and requirements to provide quality service to its customers.

Q. **DO YOU HAVE A RESPONSE TO MR. REIKER AND MR. RIGSBY REGARDING THE CALIFORNIA PUC FINDING THAT PARK WATER COMPANY REQUIRED A RISK PREMIUM BECAUSE OF ITS SMALL SIZE AND OTHER FACTORS?**

A. Yes. Mr. Reiker (p. 63) finds "several problems" with it. He asserts that the California CPUC, considered what Mr. Reiker classifies as numerous "unsystematic risks," in reaching a decision and thus the Arizona Corporation Commission should not rely on the CPUC finding. Instead of evaluating how the evidence in the Park case might actually indicate Park Water faced an increase in one or more systematic risks (beta, size or distress) he dismisses the CPUC decision because he concluded – without any study – that beta risk for Park Water was not higher than benchmark water utilities. Mr. Reiker's conclusion, not the CPUC finding, should be ignored. By way of footnote, in the Proposed Decision in Park Water Company's current case (A.02-03-046), the Administrative Law Judge proposed the 30 basis point risk premium should continue.

Mr. Rigsby (pp. 51-54 and 56-59) suggests that the 30 basis point premium authorized for Park Water must have been due to exposure to catastrophic events (pp.56-59) because -- in his opinion -- such a risk premium is not justified by Park being small (about the size of Arizona Water). I explain below that the evidence he relies upon to reject size as a risk factor does not provide that support and thus his opinion should be disregarded.

Q. AT PAGES 26 to 30 AND AGAIN AT PAGE 68, MR. REIKER ARGUES ARIZONA WATER IS LESS RISKY BECAUSE IT HAS LESS FINANCIAL RISK THAN HIS SAMPLE OF WATER UTILITIES. WHAT IS YOUR RESPONSE?

A. I have three responses.

First, it ignores known facts. He ignores the fact that Arizona Water, even with a book equity ratio that is less leveraged than the sample water utilities, is unable to obtain debt at a cost as low as those utilities. At the time the cost of the Company's last bond issue was set, it had a cost of debt that was 37 basis points above the cost of A-rated bonds and 49 basis pints above the cost of AA-rated bonds. Something else must be going on. The most obvious answer is that

Arizona Water has additional business risk that more than offsets its lower financial risk. The now classic study by Scott and Martin ("Industry Influence on Financial Structure," *Financial Management*, Spring 1975, pp. 67-71) found statistically significant results for unregulated firms that show "... smaller equity ratios (higher leverage use) are generally associated with larger companies" (page 70). It is reasonable to presume those unregulated firms attempted to have the lowest cost capital structures. The results of their study indicates smaller firms attempting to minimize costs will have higher equity ratios to offset higher business risks. In the case of Arizona Water, those higher business risks include its small size, lack of financing flexibility, limited access to bond markets, and the need to make significantly larger investments to address arsenic problems than the water utilities in the benchmark sample. In Docket W-1445A-00-0962, I presented a discussion of the Scott and Martin study in support of smaller companies requiring higher equity ratios. Mr. Reiker responded by offering a study by Titman and Wessels ("The Determinants of Capital Structure Choice," *Journal of Finance*, Vol. 43, March 1988). But the Titman and Wessels study cautioned readers that their study was limited to the manufacturing sector of the economy (page 9) whereas the Scott and Martin study considered twelve different industries (page 67). But notwithstanding the "duel" of alternative studies, the plain fact remains that even when Arizona Water has a higher book equity ratio than the sample companies, it cannot issue debt at a cost as low as those companies can issue debt.

Second, the fatal flaw in his analysis comes in two parts. First, Mr. Reiker has used the wrong measure of equity to implement formula (6) he presents at page 27. In response to a data request, Mr. Reiker provided documents showing the definition of "equity capital" required for his analysis was the <u>market</u> value of equity, not <u>book</u> equity that he used in his analysis. Rebuttal Table 19 shows the dramatic difference that occurs when the correct measure of equity capital is adopted. Instead of the unlevered beta being .36, it is .46. But of greater importance to the argument Mr. Reiker makes, the relevant equity ratio for the sample companies becomes 68%, not 50%, no matter what measure of beta is used. The second part of the fatal flaw is that Mr. Reiker cannot know what Arizona Water's "market value" is because the Company does not have one. Arizona Water only has a book equity ratio of .65 to compare to the market equity ratio of .68 for the sample companies. Without speculating about what Arizona Water's unknown "market price" would be, Mr. Reiker cannot make the calculation of the "relevered" beta he pretends can be computed. (If, for example, the Company's market-to-book ratio were equal to 1.0, Arizona Water would be more, not less leveraged than Mr. Reiker's water sample.) Mr. Reiker's analysis has no foundation and thus should be ignored.

Third, even if all of the other faults in his analysis at pages 26-30 were ignored, Mr. Reiker's analysis is flawed because he has assumed his answer when he assumes that Arizona Water has the same business risk (i.e., unlevered beta) as other water utilities. He has no evidence to make such a result-driven assumption. One cannot compute a "relevered" beta for Arizona Water from an unlevered beta for utilities with lower business risk (and thus a smaller unlevered beta). Mr. Reiker does not and cannot know the magnitude of Arizona Water's unlevered beta from the data he has presented.

Q. DOES ARIZONA WATER REQUIRE AN EQUITY RISK PREMIUM BECAUSE IT IS SMALLER THAN THE UTILITIES IN THE WATER UTILITIES SAMPLE ADOPTED TO MAKE BENCHMARK EQUITY COSTS?

A. Yes, it does. There is general agreement that there is a small firm effect and that small firms (in general) require a higher return than larger firms. Every year for the past several years, Ibbotson Associates have published studies that show smaller firms have bigger betas than larger firms and even when the bigger betas are recognized, small firms still require an additional risk premium. Fama and French also have conducted studies in which they found there are three -- not just one -- systematic risks. Those systematic risks relate to the market (the traditional CAPM beta), size (smaller is more risky) and distress (more distress requires higher returns). The question is not whether there is a small firm effect but whether there is a small firm effect for utilities as well as other stocks.

Q. YOU SAY SOME SCHOLARS HAVE ESTIMATED MORE THAN ONE SYSTEMATIC RISK. HOW DO YOU DISTINGUISH BETWEEN SYSTEMATIC AND UNSYSTEMATIC RISKS?

A. The original Sharpe-Lintner CAPM splits risk into two categories: systematic risk (beta risk) and unsystematic risk. Assuming markets are efficient and that investors price stocks to reflect expected returns, realization of the unsystematic risks in the future would be random and thus not priced by investors. Unsystematic risks are the result of unexpected events and would not be priced by investors. Investors may well take into account an expectation that old water mains will have to be replaced by water utilities. In the more complete asset pricing model, stock prices for water utilities with larger future investment requirements would be lower (relative to book value) than stock prices for water utilities with mains that have already been replaced. This market response would most logically be reflected in what Fama and French have called "distress" systematic risk. It might also impact beta risk. In this multi-risk model, there are still unsystematic risks. But those unsystematic risks occur as unexpected damage to mains occurs or the mains wear out faster or slower than expected. Risk related to expected expenditures to replace mains (compared to other water utilities) would already be priced by investors.

Mr. Reiker and I agree that unsystematic risks would not be priced by investors. But the true unsystematic risk (in the example) relates to unexpected changes in returns caused by the need to replace mains. The risk associated with the expected cost of replacing mains would already be priced by investors. With Mr. Reiker's simplistic view of the world, all of the risk – expected and unexpected -- would be classified as "unsystematic risk" and ignored unless it caused a difference in covariance with market returns.

The original CAPM can be expressed as a "Security Market Line". Professor Sharpe, one of the authors of that original CAPM, states that "other factors may matter" to investors, other than beta risk and return. In such a case Professor Sharpe says those other factors require consideration of a "security market plane" instead of the simple security market line. Sharpe, *Investments,* Third Edition, 1985, page 176-179. Specifically, Sharpe says:

> In an efficient market, all securities will plot on a *Security Market Hyperplane,* the axes of which plot contributions to all the attributes of efficient portfolios that matter (on average) to investors.

If, on average, an attribute is *liked* by investors, securities that contribute more to that attribute will, other things equal, offer *lower* expected returns. (emphasis in original) Sharpe, page 178.

As I use the term "systematic risk" I include all of those attributes (factors) that studies have found matter to investors. As I explained in my direct testimony, Ibbotson Associates conclude those systematic risks are risks related to the market and risk of company size. Fama and French have concluded the risks priced by investors are related to the market, distress and company size.

Q. **MR. REIKER SPECIFICALLY SAYS THAT FIRM SIZE IS NOT A FACTOR THAT INVESTORS PRICE WHEN THEY BUY UTILITY STOCKS, THAT SIZE IS AN "UNSYSTEMATIC RISK" AND THUS SHOULD BE IGNORED. DO YOU HAVE ANY RESPONSE TO HIS TESTIMONY?**

A. Yes. Mr. Reiker addresses this issue at pages 59 to 68 of his testimony. At page 59, he pats himself on the back because in two cases the Commission accepted his contention that the small firm effect does not exist for utilities. At page 60, he agrees that several studies have investigated the "firm size phenomenon". He specifically mentions Ibbotson Associates who have determined there is a small firm effect for common stocks in general, but notes the Ibbotson Associates study was not specific to the public utility industry. At page 60-61 he discusses the Wong study, the evidence Staff relies on to claim that though the small firm effect applies to stocks in general it does not apply to Arizona Water.

Q. **DOES MR. RIGSBY ALSO RELY ON THE WONG STUDY ?**

A. Yes, at page 48 he states that the Wong article provides a compelling argument as to why the size effect found by Ibbotson Associates for stocks in general does not apply to utilities.

Q. **DO YOU HAVE NEW EVIDENCE THAT THE WONG ARTICLE SHOULD BE DISREGARDED?**

A. Yes. Given the importance of this issue to the determination of a fair rate of return, I prepared an article and submitted it to *The Quarterly Review of Economics and Finance,* the successor to the journal that published Ms. Wong's article. My article, which is titled "Utility stocks and the size effect - revisited," *The Quarterly*

Review of Economics and Finance, 43 (2003) pages 578-582, went through the normal review and approval process of a scholarly journal. The journal received it January 7, 2002, reviewed and tentatively approved it in early 2002, sent it back to me for some editorial corrections, accepted it August 29, 2002 and will publish it this fall. I have attached at Tab C a pre-publication copy (an offprint) of that article sent to me by the publisher as Exhibit -TMZ-4.

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS IN THAT ARTICLE.

A. The primary conclusions are (1) Ms. Wong did not question the small firm effect exists for industrial stocks but, contrary to the quotation Mr. Reiker relies on, her results do not rule out such an effect for utilities. (2) Alternative beta estimation techniques are expected to show small, thinly-traded utilities are more risky than larger ones. The methods Wong used to estimate betas would not capture such a result. (3) New information not available to Wong indicates there is a small firm effect in the utility sector.

Q. IS YOUR ARTICLE IMPORTANT FOR THIS PROCEEDING?

A. Yes. My article has been subject to independent review by scholars who realized the importance of it and accepted it for publication. My article shows the Wong article cannot be relied upon to claim there is no small firm effect for utilities.

Q. BASED ON YOUR STUDY, IS THE QUOTE PRESENTED BY MR. REIKER AT PAGE 61, LINES 8-16, SUPPORTED BY THE ANALYSIS WONG PRESENTED IN HER PAPER?

A. No, it is not. I address that quote in my paper. The second sentence in that quotation from Wong's article is factually incorrect. Actually, Wong did find utility betas varied inversely with size in one of two periods. Her Table 2 shows that result. Mr. Reiker just reported the quotation but did not bother to review the evidence Wong presented in Table 2. In my article, I explain why betas estimated for the second period, at least betas for small capitalized, thinly-traded utilities, are expected to be biased downward with the type of data Wong used to make beta estimates. Also, I explain that Wong's verbal justification for expecting no small firm effect for utilities when there is a small firm effect for other companies (the part of the quotation emphasized by Mr. Reiker) is inconsistent with regulatory procedures. Wong referenced two studies and suggested that the small firm effect may be explained by investors having more information for large companies than for small companies. She then incorrectly presumed that a differential in information does not apply to utilities. Wong was apparently unfamiliar with the fact that more information will be generated for large utilities than small utilities in rate cases and that in some jurisdictions large firms are required to file more information. It was a lack of a differential in information that led Wong to presume risks for different utilities would not depend on size (Exhibit TMZ-4). Knowledgeable investors would know there is a difference in information available for large and small utilities.

Q. **DOES THE WONG ARTICLE SUPPORT A CONCLUSION THAT THERE IS NO SMALL FIRM EFFECT FOR UTILTIES?**

A. No, it does not.

Q. **MR. REIKER AND MR. RIGSBY DISCUSS THE SO-CALLED "JANUARY EFFECT". DO YOU HAVE A RESPONSE TO THEIR TESTIMONY?**

A. Yes. They both suggest there may be no "January Effect" for utilities. Even if that is the case, it does not rule out the small firm effect. There are at least two independent justifications of the small firm effect that apply equally to small utilities and other small companies. One is the differences in information available to investors (see my paper, Exhibit TMZ-4) that refers to papers by Barry and Brown (1984) and Brauer (1986)). There is indeed less information generally available to investors of small utilities than larger ones and thus that justification of the small firm effect does not depend on there being or not being a January Effect for utilities.

Second, small firms are expected to have larger betas. Ibbotson Associates (2003) and Roll (1980) suggested the small firm effect may be in part explained by negatively biased beta estimates for the smaller thinly-traced stocks that is expected to occur when the time interval used to estimate betas is a month or less. I found that to be the case when I estimated betas for Dominguez Water and also find that to be the case in my article (Table 1, Exhibit TMZ-4). With such understatements of beta risk, there is a residual risk of relevance to investors that is the small firm effect. Such a potential beta estimation problem clearly exists for utilities as well as other small companies.

And, as to the discussion presented by Mr. Rieker, he offers only speculation and no quantitative study that supports the lack of a January Effect for small utilities. Investors could sell small utility stocks before the end of the year and buy them back in January, just like any small stock. Mr. Reiker suggests that the January Effect "would be larger for small firms because stocks of small firms are more volatile" (Reiker, page 62, line 4). If that is the reason for the small firm effect, it supports a small firm effect for the smaller water utilities (as compared to larger water utilities) if those small utilities have more volatile returns than the larger ones. Mr. Reiker gets confused and implies the small firm effect of relevance is based on a comparison of utilities to companies in other types of industries. (Reiker, page 62, line 8-9) That is not the issue. The small firm effect that should be recognized is the adder to the benchmark equity return for the larger water utilities. But whether the January Effect does or does not exist, it is only one of several explanations of the small firm effect.

Q. IN RESPONSE TO YOUR STUDIES THAT SHOW SMALL WATER UTILITIES HAVE A HIGHER EQUITY COST THAN LARGER ONES, AT PAGES 44-47, MR. RIGSBY PRESENTS HIS INTERPRETATION OF A CHAN & CHEN ARTICLE, CLAIMS THE SMALL FIRM EFFECT IS DUE TO "MARGINAL FIRMS" AND THEN PROCEEDS TO COMPARE ARIZONA WATER TO SUCH MARGINAL FIRMS. DID YOU RELY ON THE CHAN & CHEN ARTICLE IN YOUR TESTIMONY?

A. No.

Q. DO YOU HAVE ANY COMMENTS ABOUT MR. RIGSBY'S ATTEMPT TO APPLY THAT ARTICLE TO ARIZONA WATER?

A. Yes. I presented an analysis of water utilities in Table 8 of my direct testimony that compared the risk of two small water utilities to the risk of two larger water utilities. I found the smaller water utilities required an equity return that was 99 basis points higher. Neither of the two small utilities were "marginal firms" as Mr. Rigsby defines the term but those small water companies still had a higher cost of equity. Mr. Rigsby has made no showing that small water utilities must be "marginal firms" to be more risky and thus his attempt to compare Arizona Water to Chan & Chen's "marginal firms" does not address the issue of small water companies being more risky than large, publicly-traded ones.

Q. MR. REIKER AND MR. RIGSBY CORRECTLY POINT OUT THAT THE CPUC STUDY YOU PRESENTED IN YOUR DIRECT TESTIMONY IS FOR UTILTIES THAT ARE SMALLER THAN ARIZONA WATER. EXPLAIN WHY YOU INCLUDED A DISCUSSION OF THAT STUDY.

A. I presented it because it shows small water utilities have higher equity costs than the water utilities that Mr. Reiker, Mr. Rigsby and I use to determine benchmark equity costs. I did not propose that Arizona Water be authorized a risk premium as large as the risk premium required by water utilities the size of Class C and Class D water utilities in California. I presented the CPUC study to show that as water utilities are smaller, they require higher and higher ROEs than the larger water utilities.

Q. **MR. REIKER ALSO CLAIMS THAT THE CPUC STAFF "COMPLETELY IGNORED FINANCE PRINCIPLES" WHEN IT ESTIMATED PROXY BETA ESTIMATES FOR THE SMALL PRIVATELY HELD WATER UTILITIES. DO YOU HAVE A RESPONSE?**

A. Yes, the firms being examined were privately held and proxy estimates of betas were made. Mr. Reiker has provided no showing that the method used by the CPUC Staff to make proxy estimates of betas was not the best available one. Indeed, the fact that another public utility commission has taken a position contrary to Mr. Reiker indicates that Mr. Reiker's position is questionable. But more fundamentally, Mr. Reiker ignores the work of scholars such as Sharpe, who recognize there may be factors other than beta risk that are systematic risks of importance to investors. All risks other than beta risk are not automatically "unsystematic risk". Unsystematic risk is risk related to unexpected events. If a factor such as company size is priced by investors, it is <u>not</u> an unsystematic risk. Mr. Reiker apparently is unwilling to acknowledge that there are potential systematic risks related to company size and to distress that may not fall neatly into whatever he means by "corporate finance principles".

Q. **AT PAGE 64 TO 68 AND IN EXHIBIT JMR-1, MR. REIKER PRESENTS A CRITICISM OF YOUR ANALYSIS IN TABLE 8. DO YOU HAVE A RESPONSE?**

A. Yes. I respond to each of his criticisms in turn. First, he claims that I did not perform the appropriate statistical test and that if I had performed a "standard statistical test" it is plausible that the average difference between the costs of equity to larger and smaller water utilities is zero.

I conducted the correct statistical test. It is called a "Paired Difference Test." I have attached at Tab C, and labeled as Exhibit TMZ-5, a section from Professsor William Mendenhall's book *Introduction to Statistics* that explains why the test I performed is correct and the one that ACC Staff presented should not be used. Professor Mendenhall provides an example that is analogous to the analysis in my Table 8. Professor Mendenhall shows that if the "standard statistical test" (the one proposed by ACC Staff) were performed in a situation where the analyst is interested in whether there are significant differences in wear for two different types of tires (analogous to small and large water utilities equity costs) when those tires are mounted on five different cars driven by five different drivers (analogous to annual estimates of equity costs), the relatively large variability in the data would suggest there is no difference in wear on the tires (analogous to large difference in equity costs during an 11 year period) when a correct test would show there is a difference.

In Professor Mendenhall's example, there would be large variability in measured tire wear because the different drivers have different driving habits (analogous to difference in credit conditions in different years). Mendenhall goes on to point out that the statistical procedure proposed by ACC Staff requires the two samples be *independent* and random when tire wear (and equity costs at different points in time) is not. The pair of measurements of tire wear for a particular automobile (analogous to the pair of equity costs in a particular year) are definitely related. He points out that tire wear (equity cost estimates) are largely determined by driver habits (financial conditions in various years) and thus

Mendenhall concludes the paired difference test I use is appropriate and the test proposed by Mr. Reiker will substantially overstate uncertainty with the results.

Mr. Reiker's proposed test is wrong and should be ignored. I also note the editors and the referees of *The Quarterly Review of Economics and Finance* found no fault with the test I performed and accepted my Table 8 as Table 2 of my soon to be published article.

Q. DO YOU HAVE ANY OTHER OBSERVATIONS ABOUT THE RESULTS YOU REPORT IN TABLE 8?

A. Yes. As a check on the observation that the various pairs of observations are not independent, one can test if the correlation between the two variables is significantly different than zero. It is. An F-test on whether the correlation between the observations is significantly different than zero produces a test statistic of 58.72. The F-statistic for the lowest level of significance (1%) in the table I examined was but 10.56. The obvious point – that equity costs at different points in time are dependent – is confirmed by the F-test. Clearly the pair-difference test I performed is the appropriate test and not the general test adopted by Mr. Reiker.

Q. DO YOU HAVE A RESPONSE TO HIS SECOND CRITICISM?

A. Mr. Reiker claims the only way I could find results to be statistically significant is to adopt an unusually low significance level. I do not agree I adopted an "unusually low," significance level. I don't know what that means. A standard t-table included in Yamane, *Statistics: An Introductory Analysis,* reports significance levels in a t-table of between 25% and 0.05% in one tail. The 10% value I adopted is neither the highest or lowest value in the table.

Q. MR. REIKER'S THIRD CRITICISM OF YOUR TEST IS THAT YOU USED A ONE-TAILED TEST. WHY DID YOU DO THAT?

A. I did it because the issue is not whether there is a small firm effect in general but whether there is a small firm effect for water utilities as well as other companies. The two-tailed test suggested by Mr. Reiker ignores the fact that scholars generally agree there is a small firm effect for stocks in general. The two-tailed test presumes there is a possibility that larger utilities could require a higher return than small utilities. No one, not even Mr. Reiker, has made such a suggestion. His suggestion for a two-tailed test is result-driven and inconsistent with the test that should be made.

Q. AT PAGE 67, MR. REIKER COMPARES THE STUDY YOU PRESENTED TO THE COMMISSION IN 2000 WITH THE STUDY IN TABLE 8. HOW ARE THEY DIFFERENT?

A. The studies are different primarily because I did not include 5-year EPS growth as one of the growth estimates in the more recent study. The goal of my study was to find proxies for forward-looking estimates of growth that investors would have relied upon to price stocks when I only had historical information. In reviewing my earlier study, I noticed that 5-year EPS growth estimates were especially volatile but that when they were included or excluded from the growth rate estimates, the average difference in equity cost estimates changed by only 2 basis points. I do not think investors expect future growth to be as volatile as it was in past five-year periods and thus revised the study.

Mr. Reiker's quotation at page 67 from the Fischer Black article refers to scholars conducting studies with limited data compiled by the University of Chicago Center for Research in Security Prices ("CRSP"). CRSP has done research and improved the quality of the data available to scholars. Clearly Black does not call such improvements "data mining". The changes in data I made from the original study to the current study were also designed to improve the data, in this case data to determine future growth rates from limited data on past growth. The quotation Mr. Reiker presents does not apply to my attempts to improve the quality of the data used in the study.

IV. RESPONSE TO MR. REIKER AND MR. RIGSBY'S CAPM ESTIMATES

Q. HOW IS THIS SECTION OF YOUR TESTIMONY ORGANIZED?

A. Mr. Reiker and Mr. Rigsby present equity cost estimates based on the CAPM. In this section of my testimony, I discuss different methods that could be used to implement the CAPM, discuss problems with the methods adopted by Mr. Reiker and Mr. Rigsby and present restatements of their CAPM results using long-term Treasury rates as the risk-free rate.

Q. DO YOU HAVE ANY GENERAL CONCERNS WITH EQUITY COST ESTIMATES BASED ON THE CAPM?

A. Yes. The CAPM is a special case of the risk premium approach,

(1) Equity cost = Bond rate + Company Risk Premium

A general form of the CAPM can be written as

(2) Equity cost = R_Z + Beta x $[E(R_M) - R_Z]$ + SR ,

Where R_Z is the return required by a risk-free asset (an asset with a beta of zero) replaces the bond rate, beta is the risk of the utility relative to changes in market returns, $[E(R_M) - R_Z]$ is a market risk premium over the zero-beta asset and the term "SR" represents any other systematic risks that investors consider in the pricing of stocks. In this general form of CAPM, all of the terms other than R_Z replace the "company risk premium". Both Mr. Reiker and Mr. Rigsby adopt a very specific version of the CAPM written as

(3) Equity cost = R_F + Beta x $[E(R_M) - R_F]$

in which the return for a Treasury security (R_F) is adopted as the measure of the required return for the zero-beta asset and it is assumed that any other systematic risks (SR) are not priced by investors. This form of the CAPM is usually called the Sharpe-Lintner version of CAPM after William Sharpe and John Lintner who originally derived it.

There are problems deciding how to implement the model, problems with making estimates of betas and market risk premiums, and problems with deciding what value to adopt for the risk free (zero-beta) asset. Based on my experience, most regulatory jurisdictions do not give CAPM much weight when determining equity costs. One of the few regulatory commissions that gave CAPM any weight was the Oregon PUC. Recently, the Oregon PUC Staff abandoned presenting equity cost estimates based on the CAPM altogether. If the Sharpe-Lintner version of the model is considered, the measure of R_F is usually a long-term Treasury rate, not either the intermediate-term Treasury rate adopted by Mr. Reiker or the 91-day Treasury rate adopted by Mr. Rigsby.

Q. WHAT ARE THE ISSUES WITH BETA ESTIMATES?

A. In general, there are problems with making estimates of betas. But with <u>water</u> utilities the task of estimating betas is especially problematical. Most water utilities are thinly-traded. Over 20 years ago, Professor Roll presented an analysis that showed if betas for thinly-traded stocks were estimated with short-interval data, such as monthly or weekly returns, the beta estimates would be biased downward (Richard Roll, "A Possible explanation of the small firm effect", Unpublished manuscript, University of California, Los Angeles, October, 1980). Ibbotson Associates reached the same conclusion and have suggested using annual data as one means to reduce the bias resulting from smaller stocks being thinly traded (Ibbotson Associates, *Valuation Edition, 2003 SBBI Yearbook,* p.132). In this proceeding, Mr. Rigsby and Mr. Reiker rely upon *Value Line* betas that are based on estimates made with weekly data. All of the water utilities are relatively small companies and thus betas estimates for them are expected to be biased downward.

Q. **ARE THERE ISSUES WITH MARKET RISK PREMIUM ESTIMATES?**

A. Yes. The task of estimating the current market risk premium is not an easy one. Mr. Reiker wisely presents a relatively wide range of expected market returns to make his estimates. Mr. Rigsby assumes that the average arithmetic return earned in the past is expected to be earned in the future. Whatever the estimate of the market risk premium, it must be internally consistent with the choice of the risk-free (zero-beta) asset also used in the analysis.

Q. **IS THERE A PREFERRED METHOD TO IMPLEMENT THE CAPM?**

A. Yes. The preferred method to implement the CAPM is to estimate the more general risk premium approach, equation (1). With that approach, the estimated company risk premium provides a direct estimate of the risk premium relevant for a utility and thus it (a) includes (beta times the $[E(R_M) - R_Z]$), (b) includes any required compensation for other systematic risks priced by investors and (c) it reflects the difference between the bond rate and the required return for the zero beta asset. With this approach, there is no need to estimate betas or market risk premiums and there is no reason to determine if "beta risk" is the only risk of relevance to investors holding shares of water utilities. In adopting such company risk premium estimates it is assumed that more reliable estimates of current equity costs can be made by assuming the past relationship between beta, market risk premiums and other systematic risks (whatever they are) continues into the future than to attempt to make individual estimates of each of the inputs (betas, current market risk premium and return on the zero-beta asset) as well as assuming (instead of estimating) what systematic risks are relevant to investors. I have made such risk premium estimates in my direct testimony and have updated them above.

Q. TURN TO YOUR MORE SPECIFIC COMMENTS ABOUT THE CAPM ESTIMATES THAT MR. REIKER AND MR. RIGSBY HAVE MADE. HOW HAVE THEY IMPLEMENTED THE MODEL?

A. Both of them assume that Treasury security rates are a good proxy for the zero-beta asset (though they use different Treasury rates), adopt *Value Line* beta estimates for water utilities as the proxy beta for Arizona Water and compute market risk premium estimates from current and historical data.

Q. HAVE EITHER MR. REIKER OR MR. RIGSBY PRESENTED ANY EVIDENCE THAT THE BETA FOR ARIZONA WATER IS THE SAME AS THE AVERAGE BETA FOR THEIR SAMPLES OF WATER UTILITIES?

A. No, they have not. Arizona Water is not publicly traded and thus does not have an estimated beta that is comparable to the *Value Line* estimates of betas they rely upon. Evidence I have seen indicates Arizona Water's true beta (but not measured beta) is closer to 1.0 than the betas for other water utilities and thus is more risky.

Q. DO YOU HAVE ANY CONCERNS WITH USING THE SHARPE-LINTNER VERSION OF THE CAPM TO MAKE EQUITY COSTS FOR WATER UTILITIES?

A. Yes. The Sharpe-Lintner model was based on an assumption that investors could borrow and lend money at the Treasury bill rate. This is a wrong assumption because it is obvious that we can loan money to the Federal Government at the Treasury bill rate by buying Treasury bills; however, we are all more risky as borrowers than the Federal government and thus cannot borrow money at such a low rate.

Q. WHAT HAPPENS TO THE SPECIFICATION OF CAPM IF A MORE REALISTIC ASSUMPTION IS MADE THAT INVESTORS CANNOT BORROW AND LEND AT THE TREASURY BILL RATE?

A. CAPM calls the relationship between required returns (in a graph, on the vertical or "y" axis) and beta risk (on the horizontal or "x" axis) a "Security Market Line" ("SML"). That SML will slope upward to the right reflecting that as risk increases required returns also increase. If a more realistic assumption about borrowing funds is made, the SML will be a flatter line than the SML of the original Sharpe-Lintner version of CAPM and the intercept (where the SML intersects the "y" axis) will be above the rate the Federal government can obtain when it sells Treasury bills. This change in assumption about borrowing and lending rates is one of the justifications of the "zero-beta" version of CAPM discussed above.

Q. WHAT IS THE IMPLICATION OF THIS CHANGE IN ASSUMPTION FOR EQUITY COST ESTIMATES FOR LOW BETA STOCKS SUCH AS UTILITIES?

A. It means that all stocks have required returns that are closer to the return required for an average stock than the original Sharpe-Lintner model predicted. This is important in the determination of the costs of equity for utilities because it means that the costs of equity for utilities (with betas less than 1.0) are closer to the cost of equity for an average risk stock than the Sharpe-Lintner model predicts.

Q. ARE THERE OTHER THEORETICAL REASONS TO EXPECT THE REQUIRED RETURN FOR AN ASSET WITH A BETA OF ZERO TO BE HIGHER THAN THE RETURN ON TREASURY BILLS?

A. Yes. Fischer Black, co-author of one of the seminal articles that tested the original version of CAPM (Black, Jensen and Scholes, "The Capital Asset Pricing Model: Some Empirical Tests," in Michael Jensen, ed., *Studies in the Theory of Capital*

Markets. New York: Praeger, 1972, pages. 79-121), lists several theoretical reasons for the required return on the zero-beta asset being higher than the Treasury bill rate assumed in the original CAPM. (Fischer Black, "Return and Beta," *Journal of Portfolio Management,* Volume 20, No. 1, Fall 1993, pp. 8-18.)

Q. WHAT HAVE THE EMPIRICAL TESTS OF CAPM GENERALLY FOUND TO BE THE APPROPRIATE RETURN FOR THE RISK-FREE ASSET?

A. Empirical tests of the Sharpe-Lintner model have found that the required return for the zero-beta asset is higher than the Treasury bill rate. Thus, market data indicate the zero-beta specification of CAPM provides a better explanation of the "real world" than the original Sharpe-Lintner model.

Q. YOU MENTIONED PROFESSOR SHARPE WHO WAS ONE OF THE SCHOLARS WHO ORIGINALLY DEVELOPED THE CAPM. WHAT HAS HE HAD TO SAY ABOUT THIS SUBSEQUENT RESEARCH?

A. Professor Sharpe has agreed with those findings and has included them in his book *Investments.* The original Sharpe-Lintner model predicts the intercept of the SML with the vertical axis (where beta is zero) should not be statistically different than the return on Treasury bills. Empirical tests have been made to see if that was the case. William Sharpe reports in both his original textbook (e.g., Sharpe, *Investments,* Third Edition, 1985, page 176) and in a recent update of that textbook (Sharpe, Alexander and Baily, *Investments*, Sixth Edition, 1999, page 246) that major tests of the model have found that the expected return on the risk-free asset is higher than what the original CAPM predicted. Sharpe concluded that

> Many organizations that estimate the SML generally find that it conforms more to the zero-beta CAPM than to the original CAPM. (Sixth Edition, p. 247 see also the Third Edition, page 176).

Also, Fischer Black updated the original tests of the Sharpe-Lintner version of CAPM he conducted with Jensen and Scholes, using data from 1926 to 1991, and found that

> low-beta stocks did better [than the original CAPM would predict] after the [Black, Jensen and Scholes] study period than during it. They did best of all in the most recent decade." (Black (1993), page 16).

Such a result also supports the conclusion that water utilities require a higher equity return than is indicated by the version of the CAPM adopted by Mr. Rigsby and Mr. Reiker.

Q. YOU HAVE TWICE MENTIONED A STUDY BY FISCHER BLACK IN SUPPORT OF THE USE OF THE ZERO-BETA CAPM. IS ACC STAFF AWARE OF THAT STUDY?

A. Yes. Mr. Reiker provides a quote from it at page 67 of his testimony. Staff apparently believes that the Black study is important enough to quote, but ignores the substance of the study. Black found the Sharpe-Lintner version of the CAPM has understated required returns for companies with average betas of .50 during the period 1996-1991 by 3% (if Mr. Rigsby's version of the model is adopted) and by about 2% if the version of the model Mr. Reiker advocates is adopted. Neither Mr. Rigsby nor Mr. Reiker correct for the expected bias in equity cost estimates for water utilities that was found by Black.

Q. DO MR. RIGSBY AND MR. REIKER'S MODIFICATIONS OF THE SHARPE-LINTNER VERSION OF CAPM SOLVE THE PROBLEM OF THE MARKET REQUIRING A RETURN ON THE RISK-FREE ASSET THAT IS HIGHER THAN THE RETURN ON TREASURY BILLS?

A. No. Mr. Rigsby adopted 91-day Treasury bill rates for his CAPM analysis. Such rates are virtually the same as the Treasury rates used in the empirical studies and thus his choice of the Treasury bill rate to make his CAPM estimates will lead to equity cost estimates for water utilities that are expected to be biased downward.

Mr. Reiker modified the Sharpe-Lintner version of CAPM and adopted intermediate-term Treasury securities as the risk-free asset. That choice moved the model in the right direction because, on average, intermediate term Treasury securities provide a return that is approximately 100 basis points higher than Treasury bill returns. (This is the average difference between equity risk premia based on intermediate term Treasury income returns and Treasury bills for the period 1926-2002, Table 9-1, Ibbotson Associates, *SBBI 2003 Yearbook.*) However, the modification did not increase the return on the risk free-asset enough.

Q. WHAT IS THE DIFFERENTIAL BETWEEN TREASURY BILLS AND THE ZERO-BETA ASSET IMPLIED BY THE LITERATURE?

A. The Fama and MacBeth (Eugene Fama and James MacBeth, "Risk Return and Equilibrium: Empirical Tests," *Journal of Political Economy*, May/June 1973, pp. 607-636) analysis which Sharpe reports in *Investments* (Third Edition, page 401) found the required return on the risk-free asset was equivalent to 7.32 percent per year while the average Treasury bill return was but 1.56 percent per year during the period studied. That result suggests that, on average, the zero-beta return is expected to be 576 basis points above Treasury bill returns, 476 basis points above intermediate-term Treasury security yields and 436 basis points above the return investors require for long-term Treasury securities. (Differences based on differences in equity risk premiums reported by Ibbotson Associates in Table 9-1 of their 2003 SBBI Yearbook)

As mentioned above, Fischer Black (1993) updated tests of the CAPM with data for the periods 1931-1991 and 1966-1991. He found a portfolio with a beta of approximately 0.5 required returns in excess of what the traditional Sharpe-Lintner CAPM would predict of 1 percent and 3 percent, respectively. Those results imply a risk-free (zero-beta) asset requires a return in excess of Treasury bills of between 2 percent and 6 percent. (This result is found by extrapolating the excess returns of 1 percent and 3 percent for a stock with a 0.5 beta back to the vertical axis to get 2 percent and 6 percent when beta is zero. At a beta of 1.0, there is no bias.) The modified Sharpe-Lintner version of the CAPM that Mr. Reiker relied upon moved in the correct direction. However the increase of about 100 basis points in the risk-free asset return (and a corresponding decrease in the market risk premium of 100 basis points) is not nearly sufficient to address the theoretical and empirical issues raised by the zero-beta analyses.

Q. HAVE YOU RESTATED MR. REIKER'S AND MR. RIGSBY'S CAPM ANALYSES?

A. Yes. I have restated their results using forecasted values for long-term Treasury rates expected during the period new tariffs are to be in effect. Some analysts have chosen long-term Treasury securities to implement the CAPM by noting that investors price common stocks to reflect long-term returns and thus conclude that the longest Treasury security returns are relevant for determining equity returns. A better reason to make the choice is that empirical tests of the original CAPM discussed above found that the required return for the zero-beta asset is higher than either Treasury bill rates or intermediate-term Treasury rates. Also, the Treasury rate should be for the future, not 2003. My restatement of Mr. Reiker's and Mr. Rigsby's CAPM results are shown below:

Mr. Reiker (water utilities):

Equity cost	=	5.6%	+	.59 x 7.0%	=	9.7%
Equity cost	=	5.6%	+	.59 x (17.9% - 5.6%)	=	12.9%
				Average	=	11.3%

Mr. Reiker (gas utilities proxy):

Equity cost	=	5.6% + .69 x 7.0% - 1.0%	=	9.4%
Equity cost	=	5.6% + .69 x (17.9% - 5.6%) - 1.0%	=	13.1%
		Average	=	11.3%

Mr. Rigsby:

Equity cost	=	5.6% + .63 x (12.2% – 5.6%)	=	9.8%

The 7.0% market risk premium in the restatement of Mr. Reiker's CAPM results is from the same table Mr. Reiker relied upon for his premium above intermediate-term rates, but is for the long-term equity risk premium. The forecasted value for the long-term Treasury rate of 5.6% is an average of the Blue Chip consensus forecast of Treasury rates for 2004 and 2005. As I explained above, the use of "actual" current Treasury rates will understate the relevant cost of Treasury securities.

Q. HAVE YOU ALSO APPLIED A "ZERO-BETA" VERSION OF THE CAPM TO RESTATE THEIR CAPM ESTIMATES?

A. No. Empirical tests of the CAPM indicate the expected return for the zero beta asset is, on average, several hundred basis points higher than the average return on long-term Treasury securities. Estimating the cost of equity with such a model would increase the return for the zero beta asset and reduce the market risk premium by the same amount. For stocks, like water utilities stocks, the higher zero beta return would more than offset the lower company risk premium and the indicated cost of equity would be higher. Thus, my restatements of Mr. Reiker and Mr. Rigsby's CAPM approaches above understates the cost of equity that would be estimated if I had adopted a zero-beta model. My choice to use long-term Treasury securities as the proxy for the zero-beta asset provides conservative estimates of water utilities' costs of equity.

Q. IF INVESTORS EXPECT RELATIVELY LOW INFLATION AND INTEREST RATES, WHAT IS THE IMPACT ON THE MARKET RISK PREMIUM?

A. The market risk premium is expected to increase. This conclusion is consistent with the Gordon and Halpern theory and empirical studies that I discussed in my direct testimony. To be conservative, I have not adjusted upward Mr. Rigsby or Mr. Reiker's market risk premium estimates to reflect such an expected increase.

Q. WHY DID YOU USE FORECASTED TREASURY RATES IN YOUR RESTATEMENT?

A. In presenting updates of my risk premium approaches, I explained why the forecasted Baa rates, not current 2003 rates, are appropriate to determine Arizona Water tariffs. The same principle applies to Treasury rates. The equity cost of relevance in this case is Arizona Water's cost of equity when the new rates are expected to be in place. Blue Chip conducts surveys of economists and reports their long term forecasts every six months. Based on the most recent Blue Chip consensus forecast, long-term Treasury rates are expected to average 5.6% during the next two years.

V. <u>RESPONSE TO MR. REIKER'S DCF EQUITY COST ESTIMATES</u>

Q. HAVE YOU RESTATED MR. REIKER'S DCF EQUITY COST ESTIMATES?

A. Yes. Rebuttal Tables 21, 22, 23 and 24 provide the restatement of his DCF equity cost estimates as well as a summary of my restatements of his equity cost estimates for water and gas utilities.

Q. PLEASE BEGIN WITH YOUR COMMENTS ABOUT HIS CONSTANT GROWTH DCF ANALYSES. FOR PURPOSES OF YOUR

RESTATEMENT, HAVE YOU ADOPTED MR. REIKER'S DIVIDEND YIELDS BASED ON SPOT PRICES?

A. Yes. I do not believe spot prices should be adopted to compute dividend yields, but, for purposes of my restatement of his DCF equity cost estimates, I have adopted Mr. Reiker's numbers.

Q. **DO YOU HAVE ANY CONCERNS WITH THE GROWTH RATES HE ADOPTS FOR HIS CONSTANT GROWTH DCF ESTIMATES?**

A. Yes. When an industry is in transition and companies within that industry are in the process of attempting to increase their financial strength, the absolute worst indicator of future growth to use with the constant growth DCF model is past dividend per share ("DPS") growth or near-term forecasts of increases in DPS. In fact, that evidence combined with evidence that earnings per share ("EPS") growth has been and is expected to be more rapid than DPS growth provides investors a basis to expect higher growth in the future. Many water and gas utilities have chosen to grow dividends more slowly than earnings are growing. EPS growth is also expected to grow much faster in the future than DPS. Mr. Reiker reports that has been the case in Schedules JMR-2 and JMR-13. Such choices have been made by the gas and water utilities to increase financial strength and get their finances in order for the future. In particular, water utilities have sought to increase their financial strength in an era of mergers, acquisitions and a future expected to require massive amounts of new capital to fund replacement of an aging infrastructure. Such delays in DPS increases improve the prospects for long-term dividend growth as the utilities increase their retention ratios and set the stage for higher sustainable growth.

Mr. Reiker correctly reports that both the water utility sample and gas utility sample are expected to have EPS growth that will exceed DPS growth. For the water utility sample, EPS growth is expected to be 3 times faster than DPS growth. In the case of the gas utilities, EPS is expected to grow 6 times faster than DPS. See Schedules JMR-2 and JMR-13. As the utilities improve their retention ratios (as EPS grows faster than DPS), investors would recognize that the utilities will be able to grow dividends much faster in the future than in the past. Investors look forward -- not backward -- and would realize the forecasts of slow near-term growth of DPS and past slow growth in DPS are the result of actions taken by the utilities to prepare for the future and that such differential growth in EPS and DPS allows higher dividend growth in the future.

Knowledgeable investors relying on the constant-growth DCF model would not use past DPS growth or forecasts of near-term DPS growth to determine growth. Thus they should not be included in the estimated average of growth rates used to make equity cost estimates for water and gas utilities with the constant-growth DCF model.

Q. ARE THERE OTHER REASONS NOT TO INCLUDE PAST DPS GROWTH?

A. Yes. In a number of places in his testimony, Mr. Reiker acknowledges Professor Myron Gordon to be an authority on the DCF model. Dr. Gordon wrote an article with two other authors (Gordon, Gordon and Gould, "Choice Among Methods of Estimating Share Yield," *Journal of Portfolio Management (Spring 1989)*) ("GG&G") in which he found analysts' consensus forecasts of future EPS growth provided better estimates of DCF growth than did past BR growth, past DPS growth and past EPS growth. In reaching that conclusion, GG&G say the superior performance by [forecasts of earnings growth] should come as no surprise. All four estimates of growth rely upon past data, but in the case of [forecasted earnings growth] a larger body of past data is used, filtered through a group of security analysts who adjust for abnormalities that are not considered relevant for future growth. (GG&G, page 54)

To the extent that the past is relevant to the future, it is already in analysts' forecasts.

Q. AT PAGE 44, MR. REIKER STATES HISTORICAL GROWTH RATES ARE RELEVANT FOR A DCF ANALYSIS. DO YOU HAVE ANY OBSERVATIONS ABOUT HIS POINT?

A. Yes. Mr. Reiker has failed to recognize Professor Gordon's point that historical growth would already have been taken into account by professional analysts when they make their forecasts. Thus to the extent that the analysts have already taken historical growth into account in their own forecasts, Mr. Reiker's approach double-counts the past. Worse yet, with respect to past DPS growth, it gives weight to a slow growth rate that, when combined with more rapid EPS growth, actually provides a harbinger of future growth that is expected to be much faster. Analysts are expected to provide unbiased forecasts of the future and to have already taken the past into account. Also, as long as investors expect EPS to grow more rapidly than DPS, the retention ratio and thus potential growth from internal sources will increase. In such a situation, investors would not view near-term DPS growth as an indicator of average constant growth over the life of the security.

Q. DO YOU HAVE ANY EVIDENCE THAT PAST DPS GROWTH AND NEAR-TERM FORECASTS OF DPS GROWTH WOULD NOT BE CONSIDERED BY INVESTORS?

A. Yes. Any "method" used to estimate the cost of equity should provide an equity cost estimate that exceeds the cost of Baa bonds by a reasonable margin. Rebuttal Table 20 compares authorized returns in Arizona to Baa rates to determine the smallest margin that is consistent with past decisions. In making this analysis, I assume -- as I did in the analysis in Table 23 and my Rebuttal Table 14 -- that Baa rates 8 months prior to the order date provide a reasonable proxy for the level of interest rates considered during the proceeding. Rebuttal Table 20 shows the ACC has found margins above Baa rates of between 215 basis points and 466 basis points to be reasonable in the past; thus a margin at least as large as the smallest past margin should be expected. Applying an equity cost estimation method to determine the equity cost for any particular utility in a sample might lead to an equity cost that produces less than a 215 basis point margin above Baa debt, but if the method is a reasonable approach, the data for the whole sample should exceed 9.25% (the bottom of the range of expected Baa rates of 7.1% plus the smallest margin of 2.15%).

Schedules JMR-7 and JMR-18 report dividend yields for the water and gas utilities Mr. Reiker uses in his constant growth DCF model of 3.47% and 4.97%, respectively. Combining those dividend yields with past and forecasted DPS growth rates yield equity cost estimates that don't make any sense. They are as follows:

Water Utilities:				
Past DPS growth	3.47% +	2.5%	=	6.0%
Projected DPS growth	3.47% +	2.9%	=	6.4%
Gas Utilities:				
Past DPS growth	4.97% +	2.2%	=	7.2%
Projected DPS growth	4.97% +	1.4%	=	6.4%

None of those DCF estimates comes even close to the bottom of the range of 9.25%.

Q. HAVE YOU RESTATED MR. REIKER'S CONSTANT-GROWTH DCF EQUITY COST ESTIMATES WITHOUT INCLUDING PAST DPS

GROWTH AND NEAR-TERM DPS GROWTH IN THE AVERAGE GROWTH RATES?

A. Yes. The restatements are as follows:

Equity $cost_{water}$ =	3.47% +	6.13% =	9.6%
Equity $cost_{gas}$ =	4.97% +	5.95% =	10.9%

Mr. Reiker would reduce the estimate for the gas utilities by 100 basis points to 9.9%. The revised growth rates are the averages of 10-year EPS growth, projected EPS growth, 10-year intrinsic (sustainable) growth and projected intrinsic (sustainable) growth for the water and gas utilities reported by Mr. Reiker at Schedules JMR-4 and JMR-15, respectively. An equity cost for Arizona Water requires the addition of 100 to 150 basis points to the estimates for the water utilities.

Q. **PLEASE TURN TO MR. REIKER'S MULTI-STAGE DCF MODEL. WHAT DID HE DO?**

A. Mr. Reiker implemented a two-stage DCF model in which he assumes investors would look at dividend growth for five years (stage-1 growth) and then adopt a growth rate for the economy as a whole for the terminal growth rate (stage-2 growth). He solves for the internal rate of return that makes the current price equal to *Value Line's* forecasts of dividends for the first year, dividends for the next four years based on *Value Line* forecasts of DPS growth and dividends after that first five year period that grow at the terminal growth rate.

Q. **HAVE YOU RESTATED HIS MODEL ?**

A. Yes. I have restated his analyses for both the water and the gas utilities with a three-stage growth model that incorporates Mr. Reiker's estimates of dividend growth, intrinsic growth and terminal growth. The results of my restatements are shown in Rebuttal Tables 21 and 22.

As I explained above, knowledgeable investors expect the relatively slow near-term growth in DPS will be rewarded by higher future growth as the utilities gain financial strength from growing their retention ratios. A multi-stage growth DCF model should incorporate this reasonable expectation of investors and not immediately go to a final stage growth rate that has nothing to do with the improved financial strength of the utilities. Also, the multi-stage DCF model should be internally consistent with the *Value Line* forecasts Mr. Reiker relies upon to forecast initial DPS growth. *Value Line* provides forecasts of intrinsic growth (Mr. Rigsby and I call this growth, "sustainable growth") for the period 2006 to 2008. Mr. Reiker presumes *Value Line* forecasts of DPS growth are relevant to investors for 2007 and 2008 when investors have better data available. Investors relying on *Value Line* forecasts would more logically assume *Value Line* forecasts of intrinsic growth for the 2006-2008 would be relevant for a number of years following 2006. Mr. Reiker's construction of the multi-stage growth model totally ignores those important forecasts of intrinsic growth. In my restatement, I have assumed Mr. Reiker's estimates of projected intrinsic growth from Schedules JMR-3 and JMR-14, for water and gas utilities, respectively, to determine second-stage growth for ten years following 2006 (2007-2016). My third stage growth rate is the same as Mr. Reiker's second stage growth rate but starts in 2017 instead of year 6 as is assumed by Mr. Reiker.

Q. **HOW DID YOU DETERMINE PROJECTED INTRINSIC GROWTH FOR CONNECTICUT WATER SERVICE, MIDDLESEX WATER AND SJW CORP?**

A. I used the method Mr. Reiker used to estimate DPS growth for those utilities. He assumed the average of DPS growth rates for American States, California Water and Philadelphia Suburban provided a reasonable forecast of the DPS growth rate investors would expect for the remaining three. In making my multi-stage analysis, I adopted Mr. Reiker's approach to estimate initial DPS growth as well as subsequent intrinsic (sustainable) growth.

Q. PLEASE SUMMARIZE HOW YOUR MODEL DIFFERS FROM HIS.

A. I have added a second stage that recognizes both the *Value Line* forecasts of initial DPS growth and subsequent forecasts of intrinsic growth. My second stage growth is internally consistent with the *Value Line* forecasts of DPS and EPS from 2003 to 2006. In making my restatement, I have used Mr. Reiker's estimates of stock prices, next year's DPS estimates, initial DPS growth, intrinsic growth rates and the terminal growth rate of 6.5% he adopts. All of the data that I have used comes from Mr. Reiker's own tables. When *Value Line* did not provide a forecast, I adopted Mr. Reiker's approach and assumed the average for the other water utilities was expected for the ones for which there was no forecast.

Q. WHAT ARE THE RESULTS OF YOUR RESTATEMENT OF HIS MULTI-STAGE DCF MODEL?

A. My results are shown in Rebuttal Tables 21 and 22. For Mr. Reiker's water utilities sample, the average equity cost estimate is 10.1%. For the gas utilities, the average equity cost estimate is 11.1%. Mr. Reiker would reduce the gas utilities equity cost estimate by 100 basis points, thus the restated proxy estimate of the large water utilities benchmark cost of equity made with data for the gas utilities is also 10.1%. Adding the 100 to 150 basis point risk premium to those restated equity cost estimates, indicates a cost of equity range for Arizona Water of 11.1% to 11.6%.

Q. HAVE YOUR PREPARED A SUMMARY OF YOUR RESTATEMENTS OF MR. REIKER'S CAPM AND DCF EQUITY COST ESTIMATES?

A. Yes, I have. Rebuttal Tables 23 and 24 summarize my restatements of his estimates for water utilities and gas utilities estimates, respectively. Based on the method he adopts, the average equity cost estimate for water utilities and average proxy equity cost based on data for the gas utilities are both 10.6%.

VI. RESPONSE TO MR. RIGSBY'S DCF EQUITY COST ESTIMATES

Q. WHAT ARE YOUR PRIMARY CONCERNS WITH MR. RIGSBY'S DCF ANALYSIS?

A. I address two concerns. First, Mr. Rigsby agrees with me that VS growth (external growth) and BR growth (internal growth) should be recognized when determining sustainable growth rate estimates. He has, however, adopted estimates of "S" and a formula to compute "V" that will understate values of VS growth investors could reasonably expect from water utilities. Second, he has underestimated BR growth (growth from internal sources). As a result, he has understated growth and the DCF equity cost estimates. If an estimate of growth used in the DCF model is less than investors expect, the DCF equity cost will be too low.

Q. HOW DOES THE SAMPLE OF WATER UTILITIES HE USES TO DETERMINE DCF EQUITY COSTS COMPARE TO THE ONE YOU USED?

A. He uses the three large water utilities (out of four) I adopted for my analysis.

Q. FIRST, HOW DO MR. RIGSBY'S ESTIMATES OF BR GROWTH FOR HIS THREE UTILITIES COMPARE TO YOUR ESTIMATES OF BR GROWTH?

A. His estimates are of BR growth are 25, 50 and 110 basis points lower than my estimates. His estimates are based on his review of data presented in Schedule WAR–6 and his judgment. The data in WAR-6 includes BR growth rates based on data reported by *Value Line* (in column C of WAR-6 page 1 of 2) that Mr. Rigsby has not adjusted to recognize the *Value Line* convention of reporting ROEs on an end-of-year basis.

Q. HOW DO MR. RIGSBY'S ESTIMATES OF BR GROWTH COMPARE TO MR. REIKER'S PROJECTED BR GROWTH RATRES?

A. The estimates of projected BR growth reported by Mr. Reiker's in Schedule JMR-3 are also higher than the BR growth rates Mr. Rigsby adopts. In one of my restatements of Mr. Rigsby's DCF results, I have adopted the estimates of projected VS and BR growth reported by Mr. Reiker.

Q. TURN TO MR. RIGSBY'S ESTIMATE OF VS GROWTH. EXPLAIN YOUR CONCERNS WITH HIS ESTIMATES OF THE STOCK FINANCING RATE "S"?

A. The approach Mr. Rigsby has taken underestimates the stock-financing rate that rational investors would anticipate. Rebuttal Table 25 shows recent past growth in shares, forecasted future growth in shares and an average of past and future growth in the number of shares as compared to Mr. Rigsby's estimates. Mr. Rigsby's average of estimates for S are less than all three averages of past and future estimates of share growth. For my first restatement of Mr. Rigsby's DCF estimates, I have adopted his estimates of future growth in shares from Schedule WAR-6 page 1 of 2, column F to compute VS growth. This is the only change in the numbers Mr. Rigsby used to make the DCF estimate. With this change alone, his DCF equity cost estimate increases to 10.0%. The revised estimates of S and VS growth are developed in Rebuttal Table 25 and the restatement of his DCF estimate with the revised value for VS growth is shown in Rebuttal Table 26.

Q. WHAT IS THE PROBLEM WITH THE FORMULA HE USES TO COMPUTE V?

A. In estimating V, Mr. Rigsby substitutes his opinion for market data. He opines that ultimately, investors would expect stock prices for regulated utilities to drop to book value (Rigsby, page 16). Thus, instead of using the market prices to determine V called for in a market model, Mr. Rigsby uses an average of the observed market-to-book ratio and a hypothetical market-to-book ratio of 1.0 to compute his estimate of V in VS growth. When the market-to-book ratio is 1.0, V is estimated to be zero and VS growth is also estimated to be zero. If one adopts the concept Mr. Rigsby espouses, it has the affect of assuming investors expect one-half as much VS growth as is revealed by market data.

Q. WHAT ARE THE PROBLEMS WITH HIS ASSUMPTION?

A. The DCF model is a market model. If investors do indeed expect the market-to-book ratio to move ultimately toward 1.0, current prices would <u>already</u> reflect that tendency and no further *ad hoc* adjustment is required. A market model presumes investors have already taken such a possibility into account when they price a utility stock and thus any additional adjustment is unnecessary.

Q. SHOULD MARKET PRICES MOVE TOWARD BOOK VALUES IF A UTILITY'S AUTHORIZED RETURN IS EQUAL TO THE COST OF EQUITY?

A. Not necessarily. I discuss this issue at pages 30 to 33 of my direct testimony and do not repeat that testimony again. Mr. Rigsby did not explain why he disagreed with the points I raised. Table 14 of my direct testimony shows the average market-to-book ratios for water utilities followed by *C. A. Turner Utilities Reports* has been above 1.0 since at least 1991.

Q. IF AN ANALYST INCLUDES AN ESTIMATE OF VS GROWTH THAT UNDERSTATES THE MARKET PRICE, AND THUS THE MARKET-TO-BOOK RATIO INVESTORS ARE WILLING TO PAY TODAY, WOULD THERE HAVE TO BE OTHER ADJUSTMENTS TO THE EQUITY COST

ESTIMATES?

A. Yes. For consistency, dividend yields should also be based on Mr. Rigsby's hypothetical prices. That approach would reduce prices, increase dividend yields and thus increase equity cost estimates. I do not believe DCF estimates should be based on hypothetical prices and thus do not present such an exercise.

Q. DID YOU PREPARE A SECOND RESTATEMENT OF MR. RIGSBY'S DCF APPROACH?

A. Yes. For this restatement, I relied upon estimates of BR growth and VS growth Mr. Reiker presents in Schedule JMR-3 and Mr. Rigsby's estimates of dividend yields. Rebuttal Table 26 shows that if sustainable growth is based on Mr. Reiker's data and not the flawed VS growth and lower BR growth that are based largely on Mr. Rigsby's opinion, the cost of equity for large water utilities is 11.1%. I develop that estimate in Rebuttal Table 26.

Q. HAVE YOU PREPARED A TABLE THAT SUMMARIZES YOUR RESTATEMENTS OF MR. REIKER AND MR. RIGSBY'S EQUITY COST ESTIMATES?

A. Yes, I have. It is Rebuttal Table 27. Based on those restatements of their estimates, Arizona Water's cost of equity falls in a range of 10.6% to 12.8% at this time.

Q. DOES THIS COMPLETE YOUR PREFILED REBUTTAL TESTIMONY?

A. Yes.

A

Arizona Water Company

Update Table 11

Average Dividend Yields for Water Utilities Sample

	D_0/P_0	D_0 _a/	3-Month High Stock Price_b/	3-Month Low Stock Price_b/
1 American States	3.55%	$0.88	$26.86	$22.80
2 California Water	4.18%	$1.12	$28.85	$25.10
3 Philadelphia Suburban	2.46%	$0.54	$23.84	$20.63
4 SJW Corp	3.47%	$2.80	$86.49	$75.65
Average	3.41%			

Notes and Sources:
_a/ Dividends paid during last 12 months (as of May 31, 2003)
_b/ Prices during the last 3 months as of May 31, 2002.

7/22/03

Arizona Water Company

Update Table 12

Estimates of Sustainable Growth for the Water Utilities Sample

	Retention Ratios Derived from Value Line Forecasts_a,e/	Forecasted ROE_b,e/	Forecast of BR_c/ Growth	VS Growth_d/	Average Sustainable Growth
1 American States	0.47	10.5%	5.1%	1.0%	6.0%
2 California Water	0.39	10.0%	4.0%	1.6%	5.7%
3 Philadelphia Suburban	0.52	15.0%	8.1%	3.4%	11.5%
4 SJW Corp_e/	0.48	10.6%	5.3%	0.0%	5.3%
Average of column	0.47	11.5%	5.6%	1.5%	7.1%

Notes and Sources:

_a/ Based on Value Line forecasts of DPS and EPS for the period 2006-2008 published at May 2, 2003 or past retention ratios.
_b/ Value Line forecast of ROE if available, otherwise past average earned ROE.
_c/ BR growth adjusted for year-end ROE forecast by Value Line.
_d/ Estimated VS growth derived in Update Table 13.
_e/ Based on historical information for 1996-2002 reported by Value Line.

7/22/03

Arizona Water Company

Update Table 13

Estimate of Expected VS Growth for Water Utilities Sample

	Stock Financing Rate (S)_a/ (a)	Market to Book Ratio_b/ (b)	V (c)	VS growth (d)
1 American States	2.19%	1.81	0.45	0.98%
2 California Water	2.99%	2.19	0.54	1.62%
3 Philadelphia Suburban	4.97%	3.20	0.69	3.42%
4 SJW Corp	0.00%	1.61	0.38	0.00%
Average of Column		2.20	0.51	1.50%

Notes and Sources:
_a/ From Value Line data reported May 3, 2002.
_b/ As reported by C. A. Turner in June 2003.

7/22/03

Arizona Water Company

Update Table 15

Analysts Forecasts of Future Earnings Growth for Water Utilities Sample

	Zacks-[a/]	Value Line-[b/]	Average
1 American States	4.5%	6.0%	5.3%
2 California Water	5.0%	9.0%	9.0%
3 Philadelphia Suburban	8.2%	10.0%	9.1%
4 SJW Corp	_c/	_d/	
Averages:	5.9%	8.3%	7.1%

Notes and Sources:

_a/ As reported by Mr. Rigsby in WAR-7.

_b/ Value Line forecasts as of May 2, 2003.

_c/ No forecast reported by either First Call, Multex or Zacks on July 11, 2003.

_d/ Value LIne does not provide forecasts for SJW Corp.

7/22/03

Arizona Water Company

Update Table 4

Beta[a] Risk of Gas and Water Utilities Samples

	Reported by Mr. Reiker[a]	At the time AWC Filed Direct[b]
Gas Distribution Utilities		
1 AGL Resources	0.75	0.60
2 Atmos Energy	0.60	0.55
3 Laclede Gas	0.60	0.55
4 NICOR	0.90	0.60
5 NW Natural	0.60	0.60
6 Peoples Energy	0.75	0.70
7 Piedmont Natural	0.70	0.60
[d] South Jersey Industries	0.50	na
8 WGL Holdings	0.65	0.60
Average	0.67	0.60
Water Utilities		
1 American States	0.60	0.65
2 California Water	0.60	0.60
3 Philadelphia Suburban	0.70	0.60
4 SJW Corp	0.50	0.55
Average	0.60	0.60
Difference in average betas	0.072	0.00
Market Risk Premium[c]	7.0%	7.0%
Indicated difference in cost of equity (basis points)	51	0

Sources:

_a/ Schedules JMR-5 and JMR-16.
_b/ Table 4 of Zepp Direct Testimony.
_c/ Ibbotson Associates, SBBI Year Book, Table 9-1.
_d/ As estimated by *ValueLine.*

7/22/03

Arizona Water Company

Update Table 16

DCF Equity Cost Ranges Estimated for Water Utilities Sample and Arizona Water

	D_0/P_0	D_1/P_0 [a/]	Growth [b/]	Water Utilities Sample Equity Cost	Arizona Water Equity Cost [c/]
Bottom of Range	3.41%	3.7%	7.1%	10.8%	11.8%
Top of range	3.41%	3.7%	7.1%	10.8%	12.3%

Notes and Sources:
_a/ Based on $D_1 = D_0 \times (1 + g)$.
_b/ Average of estimated sustainable growth and range of growth predicted by analysts. See Update Tables 12 and 15.
_c/ Water utilities sample equity cost plus 100 to 150 basis points.

7/22/03

Arizona Water Company

Update Table 17

Average Dividend Yields for Gas Utilities Sample

	D_0/P_0	D_0 [a]	3-Month High Stock Price [b]	3-Month Low Stock Price [b]
1 AGL Resources	4.46%	$1.09	$26.98	$22.30
2 Atmos Energy	5.26%	$1.20	$24.98	$20.85
3 Laclede Gas	5.55%	$1.34	$26.92	$21.90
4 NICOR	6.43%	$1.85	$36.30	$23.70
5 NW Natural	4.82%	$1.26	$28.52	$24.13
6 Peoples Energy	5.36%	$2.10	$44.60	$34.93
7 Piedmont Natural	4.48%	$1.63	$39.69	$33.53
8 WGL Holdings	4.81%	$1.27	$28.14	$25.00
Average	5.15%			

Notes and Sources:
_a/ Dividends paid during last 12 months (as of May 31, 2003)
_b/ Prices during the last 3 months as of May 31, 2002.

7/22/03

Arizona Water Company

Update Table 18

Forecasts of Sustainable Growth for Gas Utilities Sample

	Retention Ratios Derived from Value Line Forecasts_a/	Forecasted ROE	Forecast of BR_b/ Growth	VS Growth_c/	Average Sustainable Growth
1 AGL Resources	0.48	11.0%	5.4%	0.9%	6.3%
2 Atmos Energy	0.44	14.5%	6.6%	2.8%	9.3%
3 Laclede Gas	0.26	10.5%	2.8%	0.2%	2.9%
4 NICOR	0.38	18.5%	7.2%	0.0%	7.2%
5 NW Natural	0.43	10.0%	4.4%	0.5%	5.0%
6 Peoples Energy	0.39	12.0%	4.8%	0.0%	4.8%
7 Piedmont Natural	0.38	12.5%	4.8%	0.7%	5.5%
8 WGL Holdings	0.45	11.0%	5.0%	0.2%	5.2%
Average of column	0.40	12.5%	5.1%	0.6%	5.8%

Notes and Sources:
_a/ Value Line forecasts of DPS and EPS growth and ROE as of June 20, 2003.
_b/ BR growth adjusted for year-end ROE forecast by Value Line.
_c/ See Update Table 19.

7/22/03

Arizona Water Company

Update Table 19

Estimate of Expected VS Growth for Gas Utilities Sample

	Stock Financing Rate (S)_a/ (a)	Market to Book Ratio_b/ (b)	V (c)	VS growth (d)
1 AGL Resources	1.86%	1.86	0.46	0.86%
2 Atmos Energy	7.78%	1.55	0.35	2.76%
3 Laclede Gas	0.46%	1.58	0.37	0.17%
4 NICOR	0.00%	2.02	0.50	0.00%
5 NW Natural	1.84%	1.39	0.28	0.52%
6 Peoples Energy	0.00%	1.81	0.45	0.00%
7 Piedmont Natural	1.27%	2.19	0.54	0.69%
8 WGL Holdings	0.59%	1.54	0.35	0.21%
Average of Column		1.74	0.41	0.65%

Notes and Sources:
_a/ From Value Line data reported June 20, 2003.
_b/ As reported by C. A. Turner in June 2003.

7/22/03

Arizona Water Company

Update Table 20

Analysts' Forecasts of Future Earnings Growth for Gas Utilities Sample

	First Call[a]	Value Line[b]	Average
1 AGL Resources	6.0%	8.0%	7.0%
2 Atmos Energy	6.0%	10.0%	8.0%
3 Laclede Gas	4.0%	5.0%	4.5%
4 NICOR	4.5%	3.0%	3.8%
5 NW Natural	5.0%	5.0%	5.0%
6 Peoples Energy	5.0%	4.0%	4.5%
7 Piedmont Natural	5.0%	7.5%	6.3%
8 WGL Holdings	4.0%	7.0%	5.5%
Averages	4.9%	6.2%	5.6%

Notes and Sources:

_a/ First Call average forecasts reported on Internet on July 11, 2003.

_b/ Value Line forecasts as of June 20, 2003.

7/22/03

Arizona Water Company

Update Table 21

DCF Equity Cost Ranges for Water Utilities Sample and Arizona Water
Based on Data for Gas Utilities Sample

	D_0/P_0	D_1/P_0 _a/	Growth _b/	Gas Utilities Sample Equity Cost	Benchmark Water Utilities Sample Equity Cost _c/	Arizona Water Equity Cost _d/
Top of range	5.1%	5.4%	5.7%	11.1%	10.6%	11.6%
Bottom of range	5.1%	5.4%	5.7%	11.1%	10.6%	12.1%

Notes and Sources:
_a/ Based on $D_1 = D_0 \times (1 + g)$.
_b/ Average of estimated sustainable growth and range of growth predicted by analysts. See Update Tables 18 and 20.
_c/ Assumes equity cost is 50 basis points lower.
_d/ Water utilities sample equity cost plus 100 to 150 basis points.

7/22/03

Arizona Water Company

Update Table 22-[a/]

Water Utility Risk Premiums Computed with Past Water Utilities ROEs and Forecasted Costs of Baa Bonds

Forecasts of Baa Corporate Rate-[b/]	Estimated Risk Premium-[a/]	Forecasted Equity Cost for Large Water Utilities	Forecasted Equity Cost for Arizona Water
7.10%	3.91%	11.0%	12.0%
7.70%	3.53%	11.2%	12.7%

Notes and Sources:
a/ Formula from Table 22 of Direct Testimonmy
b/ Blue Chip Long Range Forecast, June 2003.

7/22/03

Arizona Water Company

Update Table 23

Risk Premium Analysis[a]
Regression Analysis of Risk Premiums Based on Authorized Returns
for Natural Gas Utility Stocks and Baa Corporate Bond Rates

	Equity Cost Estimate		Predicted Premium[a]		Forecasted Baa Corporate Bond Rate[b]
Bottom	10.9%	=	3.83%	+	7.10%
Top	11.2%	=	3.53%	+	7.70%

Estimated Equity Cost for the Average Utility
in Water Utilities Sample:

Bottom	=	10.4%
Top	=	10.7%

Estimated Range of Equity Costs for Arizona
Water Company

Bottom	=	11.4%
Top	=	12.2%

Notes and Sources:
_a/ Source Direct Table 23
_b/ Blue Chip Long Range Forecast, June 2003.

7/22/03

Arizona Water Company

Update Table 24

Risk Premium Analysis[a]
Comparison of Total Returns on Moody's Natural Gas Stock Index
and Baa Corporate Bond Rates

Average Risk Premium[a] = 3.67%

Equity Cost Forecast	Forecast of Baa Bond Rates[b]	Gas Utility Equity Cost	Benchmark Water Utilities Sample Equity Cost	Arizona Water Equity Cost
Low	7.1%	10.8%	10.3%	11.3%
High	7.7%	11.4%	10.9%	12.4%

Sources and Notes:

a/ Data from Direct Table 24

b/ Range of forecasts for 2004-2005 compiled by Blue Chip, June 2003.

7/22/03

Arizona Water Company

Update Table 25

Update of Summary Table: Estimated Cost of Equity Ranges for Water Utilites Sample and Arizona Water

	Estimated Benchmark Ranges of Equity Costs for Water Utilities Sample			Estimated Range of Equity Costs for Arizona Water		
Discounted Cash Flow Estimates						
Based on Water Utilities	10.8%	to	10.8%	11.8%	to	12.3%
Based on Gas Utilities	10.6%	to	10.6%	11.6%	to	12.1%
Risk Premium Analyses Estimates						
Based on Water Utilities	11.0%	to	11.2%	12.0%	to	12.7%
Based on Gas Utilities Authorized ROEs	10.4%	to	10.7%	11.4%	to	12.2%
Based on Moody's Gas Utilities Index	10.3%	to	10.9%	11.3%	to	12.4%
Estimated Equity Cost Range for Arizona Water				11.3%	to	12.7%

7/26/03

B

Arizona Water Company

Rebuttal Table 1

Authorized Returns, Realized Returns and Forecasted ROEs for Recent Periods

	Mr. Reiker's Sample of Water Utilities		Value Line Forecasts of ROE 2 Years into the Future
Year	Authorized ROEs	Actual ROEs	
1997	11.18%	11.82%	
1998	11.06%	10.90%	
1999	11.12%	10.59%	11.00%
2000	11.12%	9.75%	11.00%
2001	10.86%	10.27%	11.00%
2002	10.62%	10.58%	10.50%
2003	10.59%	10.60%	11.00%
Average	10.93%	10.64%	10.90%
RUCO/Staff	9.20%	9.20%	9.20%
Difference	1.73%	1.44%	1.70%

7/22/03

Rebuttal Table 2

Response to Mr. Reiker's Testimony at Page 50:
Work Papers that Were Available But not Requested

A. Authorized ROEs[a/]

	AWK	AWR	CWT	CTWS	MSEX	PSC	SJW	Average
1991	12.81	12.00	12.25	12.70	12.30	12.70	12.25	12.43
1992	12.16	11.75	12.25	12.70	12.30	12.00	11.75	12.13
1993	12.16	11.75	12.25	12.70	12.30	12.00	11.75	12.13
1994	11.58	10.10	11.00	12.70	11.50	12.00	11.75	11.52
1995	11.58	10.50	11.00	12.70	11.50	12.00	11.75	11.58
1996	11.58	10.40	10.30	12.70	11.50	12.00	10.20	11.24
1997	11.16	10.40	10.30	12.70	11.50	11.25	10.20	11.07
1998	11.21	10.40	10.30	12.70	12.05	11.05	10.20	11.13
1999	11.21	10.40	10.30	12.70	12.05	11.05	10.20	11.13
2000	11.02	10.00	10.48	12.70	11.15	10.65	10.20	10.89
Average								11.52

B. Return on Average Common Equity [b/]

	AWK	AWR	CWT	CTWS	MSEX	PSC	SJW	Average
1991	12.90	11.80	11.80	5.70	12.40	10.90	18.50	12.00
1992	11.20	10.50	11.80	4.80	11.00	10.60	13.70	10.51
1993	11.50	12.50	12.40	10.20	12.90	11.40	10.30	11.60
1994	10.70	10.00	12.30	10.80	12.20	9.50	9.50	10.71
1995	11.20	10.00	12.40	11.70	12.00	10.60	10.00	11.13
1996	9.60	12.40	12.10	11.80	10.60	15.50	9.20	11.60
1997	10.40	14.20	12.10	12.10	11.50	11.40	9.30	11.57
1998	10.60	10.90	12.10	12.40	9.70	11.20	9.50	10.91
1999	8.50	11.20	12.00	9.90	11.20	11.00	10.10	10.56
2000	9.60	10.10	12.30	12.40	7.50	7.40	9.40	9.81
Average								11.04
Difference between Authorized and Realized ROEs								0.48

Notes and Sources:
a/ As reported by C. A. Turner Utilty Reports
b/ As reported by the California PUC Staff. CPUC Staff reported the sources was MSN Money Central 5/31/01.

7/22/03

Arizona Water Company

Rebuttal Table 3

Equity Risk Premium Analysis Suggested by Mr. Reiker
in Direct Testimony at Page 53

Year	Equity Cost Estimates for Large Water Utilities	Baa Rate	Risk Premium
1987	14.24%	10.58%	3.66%
1988	13.48%	10.83%	2.65%
1989	13.84%	10.18%	3.66%
1990	13.87%	10.36%	3.51%
1991	13.67%	9.80%	3.87%
1992	12.50%	8.98%	3.52%
1993	11.30%	7.93%	3.37%
1994	10.70%	8.63%	2.07%
1995	10.55%	8.20%	2.35%
1996	9.88%	8.05%	1.83%
1997	8.40%	7.87%	0.53%
Average			2.82%

	Baa Range	Equity Cost
Baa Rates -- bottom of range	7.1%	9.9%
Baa Rates -- top of range	7.7%	10.5%

7/22/03

Arizona Water Company

Rebuttal Table 4

Calculation of Unlevered betas and Implied Equity Ratios with
Market and Book Values for Equity

Value Line betas: JMR-5 and JMR-9 data

			Book Values		Market Values		
	Market betas	tax rate	equity ratio	Bu	Market to-Book	equity ratio	revised Bu
American States	0.60	0.389	0.480	0.36	1.81	0.63	0.44
California Water	0.60	0.397	0.443	0.34	2.19	0.64	0.45
Connecticut Wtr Service	0.60	0.338	0.552	0.39	2.50	0.76	0.49
Middlesex Water	0.55	0.333	0.466	0.31	2.29	0.67	0.41
Philadelphia Suburban	0.70	0.385	0.458	0.41	3.20	0.73	0.57
SJW Corp	0.50	0.404	0.583	0.35	1.61	0.69	0.40
Average	0.59		0.50	0.36		0.68	0.46

Unadjusted betas: JMR-9 data

	Raw betas	tax rate	equity ratio	Bu	Market to-Book	equity ratio	revised Bu
American States	0.37	0.389	0.480	0.22	1.81	0.63	0.27
California Water	0.37	0.397	0.443	0.21	2.19	0.64	0.27
Connecticut Wtr Service	0.37	0.338	0.552	0.24	2.50	0.76	0.30
Middlesex Water	0.30	0.333	0.466	0.17	2.29	0.67	0.23
Philadelphia Suburban	0.52	0.385	0.458	0.30	3.20	0.73	0.42
SJW Corp	0.22	0.404	0.583	0.15	1.61	0.69	0.17
Average	0.36		0.50	0.22		0.68	0.28

7/23/03

Arizona Water Company

Rebuttal Table 5

Authorized ROE Margins Above Baa Rates
in Recent Arizona Corporation Commision Cases

Date of Decision[a]	Authorized ROE	Baa Rate During[b] Proceeding	Margin
May-97	10.50%	8.35%	2.15%
May-97	11.00%	8.35%	2.65%
September-97	11.50%	8.09%	3.41%
July-98	11.30%	7.42%	3.88%
July-99	11.00%	7.34%	3.66%
July-99	12.00%	7.34%	4.66%
January-00	11.75%	7.72%	4.03%
June-00	11.50%	8.38%	3.12%
October-01	11.00%	7.87%	3.13%
December-01	10.25%	8.07%	2.18%
Average		7.89%	3.29%
Lowest margin			2.15%
Largest Margin			4.66%

Notes and Sources:

a/ Decisions reported in Table 10 of Zepp Direct Testimony.

b/ Based on interest rates prevailing 8 months prior to date of order.

7/22/003

Arizona Water Company

Rebuttal Table 6: Multi-Stage DCF Estimates
Sample Water Companies

Line No.	[A]	[B] Current Mkt. Price (P_o)[a]	[C] Stage 1 growth (2004-2006) d_{2004}[a]	[D] d_{2005}	[E] d_{2006}	[F] Stage 2 growth (2007-2016) d_{2007}	[G] d_{2016}	[H] Stage 1 Initial growth[b] (2004-2006)	[I] Stage 2 Projected Intrinsic growth[c] (next 10 years)	[J] Stage 3 Terminal growth[d] (future years)	[K] Equity Cost Estimate (K)
1											
2											
3	American States Water	26.0	0.88	0.91	0.93	0.99	1.70	2.88%	6.20%	6.5%	9.6%
4	California Water	26.9	1.12	1.13	1.15	1.19	1.71	1.16%	4.10%	6.5%	9.7%
5	Connecticut Water Services	25.4	0.85	0.88	0.90	0.97	1.91	3.10%	7.80%	6.5%	10.0%
6	Middlesex Water	22.1	0.88	0.91	0.94	1.01	1.98	3.10%	7.80%	6.5%	10.6%
7	Philadelphia Suburban	23.2	0.58	0.61	0.64	0.73	2.18	5.27%	13.00%	6.5%	10.4%
8	SJW Corp.	85.5	2.95	3.04	3.14	3.38	6.65	3.10%	7.80%	6.5%	10.1%
13										Average	10.1%

14
15 Sources:
16 a/ Schedule JMR-6
17 b/ Schedule JMR-6
18 c/ Schedule JMR-3. Relatively slow Stage 1 growth permits the higher intrinsic growth in Stage 2.
19 d/ Schedule JMR-6
20

7/21/03

Arizona Water Company

Rebuttal Table 7: Multi-Stage DCF Estimates
Sample Gas Utilities

Line No.	[A]	[B] Current Mkt. Price (P_o)[a/]	[C] Stage 1 growth (2004-2006) d_{2004}[a/]	[D] Stage 1 growth (2004-2006) d_{2005}	[E] Stage 1 growth (2004-2006) d_{2006}	[F] Stage 2 growth (2007-2016) d_{2007}	[G] Stage 2 growth (2007-2016) d_{2016}	[H] Stage 1 Initial growth[b/] (2004-2006)	[I] Stage 2 Projected Intrinsic growth[c/] (next 10 years)	[J] Stage 3 Terminal growth[d/] (future years)	[K] Equity Cost Estimate (K
1	AGL Resources	25.4	1.12	1.12	1.12	1.20	2.15	0.00%	6.8%	6.5%	10.5%
2	Atmos Energy	23.1	1.21	1.24	1.28	1.37	2.70	2.66%	7.8%	6.5%	11.8%
3	Cascade Natural Gas	18.7	0.96	0.97	0.97	1.05	2.14	0.69%	8.2%	6.5%	11.7%
4	Laclede Group	24.2	1.34	1.35	1.36	1.41	1.98	0.74%	3.8%	6.5%	10.6%
5	Nicor Inc.	31.2	1.86	1.95	2.05	2.19	4.03	4.91%	7.0%	6.5%	12.5%
6	Northwest Natural Gas	26.2	1.27	1.29	1.30	1.39	2.42	1.29%	6.4%	6.5%	10.9%
7	Peoples Energy	39.9	2.12	2.15	2.17	2.28	3.60	1.22%	5.2%	6.5%	10.9%
8	Piedmont Natural Gas	37.4	1.66	1.72	1.77	1.91	3.81	3.37%	7.9%	6.5%	11.1%
9	Southwest Gas	20.6	0.82	0.82	0.82	0.88	1.59	0.00%	6.8%	6.5%	10.1%
10	WGL Holdings	26.5	1.28	1.29	1.31	1.39	2.50	1.02%	6.7%	6.5%	10.9%
										Average	11.1%

Sources:

a/ Schedule JMR-17

b/ Schedule JMR-17

c/ Schedule JMR-14. Relatively slow Stage 1 growth permits the higher intrinsic growth in Stage 2.

d/ Schedule JMR-17

7/21/03

Arizona Water Company

Rebuttal Table 8

Revisions of Mr. Reiker's Final Cost of Equity Estimates
for the Sample Water Companies

Line No.	[A]	[B]		[C]		[D]		[E]
	Constant Growth DCF			D_1/P_0	+	$g^{-a/}$	=	k
1	Constant Growth DCF Estimate			3.47%	+	6.13%	=	9.6%
2	Multi-Stage DCF Estimate						=	10.1%
3						Average		9.8%
	CAPM Approach:	$R_F^{-b/}$	+	β	x	MRP_{RF}	=	k
4	Historical Market Risk Premium	5.6%	+	0.59	x	7.0%	=	9.7%
5	Current Market Risk Premium	5.6%	+	0.59	x	12.3%	=	12.9%
6	Average of CAPM Estimates							11.3%
7		Average of DCF and CAPM Approaches						10.6%

Notes:
a/ Average of all of Mr. Reiker's DCF growth rates other than those based on past and forecasted dividends per share.
b/ Average of Blue Chip forecasts for long-term Treasury securites for 2004-2005.

7/22/03

Arizona Water Company

Rebuttal Table 9

Revisions of Mr. Reiker's Final Cost of Equity Estimates
for the Sample Gas Utilities

Line No.	[A]	[B]		[C]		[D]		[E]	[F]
									Proxy for Large Water Utilities
	Constant Growth DCF			D_1/P_0	+	$g^{a/}$	=	k	
1	Constant Growth DCF Estimate			4.97%	+	5.95%	=	10.9%	9.9%
2	Multi-Stage DCF Estimate						=	11.1%	10.1%
3						Average		11.0%	10.0%
	CAPM Approach:	$R_F^{\ b/}$	+	β	x	MRP_{RF}	=	k	Proxy - k
4	Historical Market Risk Premium	5.6%	+	0.69	x	7.0%	=	10.4%	9.4%
5	Current Market Risk Premium	5.6%	+	0.69	x	12.3%	=	14.1%	13.1%
6	Average of CAPM Estimates							12.3%	11.3%
7	Average of DCF and CAPM Approaches							11.6%	10.6%

Notes:
a/ Average of all of Mr. Reiker's DCF growth rates other than those based on past and forecasted dividends per share.
b/ Average of Blue Chip forecasts for long-term Treasury securites for 2004-2005. .

7/22/03

Arizona Water Company

Rebuttal Table 10

Analysis of Estimates of Mr. Rigsby's Estimates of Share Growth and Restatement of VS Growth

	Growth in Number of Shares			
	Past[a/]	Forecast[b/]	Average	Mr. Rigsby[c/]
	(A)	(B)	(C)	(D)
1 American States	2.5%	2.1%	2.3%	0.3%
2 California Water	0.2%	4.4%	2.3%	1.0%
3 Philadelphia Suburban	10.9%	2.0%	6.5%	1.8%
Average	4.5%	2.8%	3.7%	1.0%

	Restatement of VS Growth		
	V	S	VS
1 American States	0.41	2.05%	0.84%
2 California Water	0.45	4.37%	1.94%
3 Philadelphia Suburban	1.03	2.00%	2.06%
Average			1.62%

Notes and Sources:
a/ For the period 1997 to 2002.
b/ For the period 2002 to 2007.
c/ Schedule WAR-5, page 2 of 2.

7/22/03

Arizona Water Company

Rebuttal Table 11

Restatement of Mr. Rigsby's DCF Estimates

A. Revise Mr. Rigsby's Estimate of the stock financing rate[a/]

	Internal Growth (BR)	External Growth (VS)	Dividend Growth (g)	Diviend Yield	DCF Cost of Equity Capital
1 American States	4.60%	0.84%	5.44%	3.41%	8.85%
2 California Water	3.75%	1.94%	5.69%	4.03%	9.72%
3 Philadelphia Suburban	7.00%	2.06%	9.06%	2.43%	11.49%
Average					10.0%

B. Adopt Mr. Reiker's estimates of BR and VS growth[b/]

	Internal Growth[b/] (BR)	External Growth[b/] (VS)	Dividend Growth[b/] (g)	Mr. Rigsby's Dividend Yield	DCF Cost of Equity Capital
American States	5.00%	1.20%	6.20%	3.41%	9.61%
California Water	4.00%	0.10%	4.10%	4.03%	8.13%
Philadelphia Suburban	8.00%	5.00%	13.00%	2.43%	15.43%
Average					11.1%

Notes and Sources:
a/ Value of "s" is revised in Rebuttal Table 10.
b/ Forecasts of BR and VS growth as reported in Schedule JMR-3.

7/22/2003

Arizona Water Company

Rebuttal Table 12

Summary of Restatements of Estimated Cost of Equity Presented by Mr. Reiker and Mr. Rigsby for Large Water Utilites Samples and Arizona Water

	Estimated Benchmark Ranges of Equity Costs for Water Utilities Sample			Estimated Range of Equity Costs for Arizona Water		
Discounted Cash Flow Estimates						
Mr. Reiker (gas and water)	9.6%	to	10.1%	10.6%	to	11.6%
Mr. Rigsby	10.0%	to	11.1%	11.0%	to	12.6%
Estimates based on the CAPM						
Mr. Reiker (gas and water)	11.3%	to	11.3%	12.3%	to	12.8%
Mr. Rigsby	9.8%	to	9.8%	10.8%	to	11.3%
Estimated Equity Cost Range for Arizona Water				10.6%	to	12.8%

7/26/03

C

BEFORE THE

PUBLIC UTILITY COMMISSION OF OREGON

UM 903

In the Matter of an Investigation	)
Into Policy Issues and Procedures	)
Associated with Recovery of	)
Purchased Gas Costs By Oregon's	)
Regulated Gas Distribution Utilities.	)

SWORN TESTIMONY OF DR. THOMAS M. ZEPP

JANUARY 21, 1999

NAEGELI & ASSOCIATES, INC. THE COURT REPORTERS

RECEIVED

JAN 27 1999

Public Utility Commission of Oregon
Administrative Hearings Division

RECEIVED

JAN 26 1999

RATES &
REGULATORY AFFAIRS

OREGON (503) 227-1544
WASHINGTON (206) 622-3376
NATIONAL (800) 528-3335
NAreport@AOL.com

DOCKETED

number out; and then let's say you put in the number 10 percent, and you get a second number out: Is the adjustment in basis points the same for the 4 percent as the 10 percent?

A. No.

Q. And how do the -- how does the adjustment differ? For example, I guess I'm trying to conclude, is the adjustMENT greater for higher interest rates than for lower interest rates?

A. The adjustment in basis points --

Q. Yes, exactly.

A. -- would be greater.

Q. For higher interest rates?

A. Yes, would be.

Q. Okay. On page 18 on line 2, you indicate your conclusion that, if investors could have information only on EPS -- and that stands for earnings per share growth, I assume -- or only on DPS -- which I assume is dividends per share growth -- investors would prefer the information about EPS growth.

Are you saying that investors give equal weight to earnings per share historical data in forecasts, and dividends per share of historical data in forecasts, in forming their expectations of dividend growth? Or are you saying that, if you had both of those sets of information, investors would prefer earnings per share?

MS. ACKERMAN: That was a long question. Do you want it broken up?

THE WITNESS: Well, it was a question that didn't refer to the testimony that's stated here. I'm -- I really have no change in the testimony. If you have a different question than what's in the testimony, that's another matter, but I think the testimony is clear.

BY MR. THORNTON:

Q. Okay. Well, I guess I'm not understanding it. If you have earnings per share growth information and dividends per share growth information, which sets of information do investors prefer, according to you?

A. According to me, investors would look at both, but this particular testimony here refers to your testimony, in which you didn't look at earnings per share growth. And my point is, if you're only going to look at one -- in my view, if you were only going to look at one, investors would look at earnings per share growth. That's the testimony, and I still stand by that testimony, but as I've stated, I would look at both.

Q. And just to clarify and give a context to the question, what is the purpose of looking at the information?

MR. GRAHAM: And which information are we talking about, the earnings per share growth?

MR. THORNTON: The earnings per share growth or dividends per share growth.

Q. I mean, why do we look at it?

A. To ultimately forecast dividend growth in the long term.

Q. Or could you also conclude to -- ultimately to estimate investors' forecasts of dividend growth?

A. Yes.

Q. Okay. On page 17, the page just before, on line 18 you indicate that available evidence indicates that they -- meaning the investors -- would look at earnings per share growth. And what is that evidence?

A. It's stated in the next two sentences.

Q. So --

A. That investors are willing to pay for publications such as the S & P Earnings Guide.

Q. Okay. Page 28, on page 28, what is your evidence -- and this is, excuse me, the Q and A beginning on line 10. What is your evidence that including global market returns would increase rather than decrease overall market returns? By "overall market returns" I mean we're technically referring to the efficient portfolio.

A. I would have to get that for you. My recollection -- I've provided that in data responses in the past. It's chapter 10 of a textbook. I'm -- to my recollection Elton and Gruber wrote it, but I would have to check on that, but it is a textbook.

MR. THORNTON: So how do we arrange that?

MR. GRAHAM: Well, let me do some follow-up here. How long would it take you to find out which textbook that is?

THE WITNESS: I'd have to go back through cases, and they are probably four or five years old. But I should -- hopefully I still have it in my work papers. It may have been submitted in a prior Northwest Natural case.

MR. GRAHAM: Do you think that you could

NORTH-HOLLAND

The Quarterly Review of Economics and Finance
43 (2003) 578–582

The QUARTERLY REVIEW of ECONOMICS And FINANCE

Short communication

Utility stocks and the size effect—revisited

Thomas M. Zepp*,[1]

Utility Resources, Inc., 1500 Liberty Street S.E., Suite 250, Salem, OR 97302, USA

Received 7 January 2002; received in revised form 27 August 2002; accepted 29 August 2002

Abstract

Wong concluded there is weak empirical support that firm size is a missing factor from the capital asset pricing model for industrial stocks but not for utility stocks. Her weak results, however, do not rule out the possibility of a small firm effect for utilities. The issue she addressed has important financial implications in regulated proceedings that set rates of return for utilities. New studies based on different size water utilities are presented that do support a small firm effect in the utility industry.

Keywords: Utility stocks; Beta risk; Firm size

Annie Wong concludes there is some weak evidence that firm size is a missing factor from the capital asset pricing model ("CAPM") for industrial stocks but not for utility stocks (Wong, 1993, p. 98). This "firm size effect" is an observation that small firms tend to earn higher returns than larger firms after controlling for differences in estimates of beta risk in the CAPM. Wong notes that if the size effect exists, it has important implications and should be considered by regulators when they determine fair rates of return for public utilities. This paper re-examines the basis for her conclusions and presents new information that indicates there is a small firm effect in the utility sector.

1. Reconsideration of the evidence provided by Wong

Wong relies on Barry and Brown (1984) and Brauer (1986) to suggest the small firm effect may be explained by differences in information available to investors of small and large firms.

* Tel.: +1-503-370-9563; fax: +1-503-370-9566.
E-mail address: tzepp@ur-inc.com (T.M. Zepp).

1062-9769/02/$ – see front matter
PII: S1062-9769(02)00172-2

She states that requirements to file reports and information generated during regulatory proceedings indicate the same amount of information is available for large and small utilities and thus, if the differential information hypothesis explains the small firm effect, then the uniformity of information available among utility firms would suggest the size effect should not be observed in the utility industry. But contrary to the facts she assumes, there are differences in information available for large and small utilities. More parties participate in proceedings for large utilities and thus generate more information. Also, in some jurisdictions smaller utilities are not required to file all of the information that is required of larger firms. Thus, if the small firm effect is explained by differential information, contrary to Wong's hypothesis, differences in available information suggests there is a small firm effect in the utility industry. Wong did not discuss other potential explanations of the small firm effect for utilities.[2]

Wong's empirical results are not strong enough to conclude that beta risks of utilities are unrelated to size. In the period 1963–1967, when monthly data were used to estimate betas, her estimates of utility betas as well as industrial betas increased as the size of the firms decreased, but she did not find the same inverse relationship between size and beta risk for utilities in other periods. Being unable to demonstrate a relationship between size and beta in other periods may be the result of Wong using monthly, weekly and daily data to make those beta estimates. Roll (1980) concluded trading infrequency seems to be a powerful cause of bias in beta risk estimates when time intervals of a month or less are used to estimate betas for small stocks. When a small stock is thinly traded, its stock price does not reflect the movement of the market, which drives down the apparent covariance with the market and creates an artificially low beta estimate.

Ibbotson Associates (2002) found that when annual data are used to estimate betas, beta estimates for the smaller firms increase more than beta estimates for larger firms. Table 1 compares Value Line (2000) beta estimates for three relatively small water utilities that are made with weekly data and an adjusted beta estimated with pooled annual data for the utilities for the 5-year period ending in December 2000. In making the latter estimate, it is assumed that the underlying beta for each of water utilities is the same. The *t*-statistics for the unadjusted beta

Table 1
Beta estimates reported by Value Line and estimated with pooled annual returns for relatively small water utilities

	Value Line[a]	Estimated with annual data[b]
Connecticut Water Service	0.45	
Middlesex Water	0.45	
SJW Corporation	0.50	
Average	0.47	0.78
t-statistic		2.72[c,d]

[a] As reported in Value Line (2000). Betas estimated with 5 years of weekly data.

[b] Estimated with pooled annual return premiums for the 5-year period ending December 2000. Proxy market returns are total returns for the S&P 500 index. Dummy variable in 1999 to reflect the proposed acquisition of SJW Corporation included in analysis.

[c] Significant at the 95% level.

[d] The *t*-statistic for the null hypothesis that the true beta is 0.18 (the derived unadjusted Value Line beta) when the estimated betas is 0.65 (the unadjusted estimated beta) is 1.97. It is significant at the 95% level.

estimate is reported in parentheses. As was found by Ibbotson Associates (2002) for stocks in general, when annual data are used to estimate betas for small utility stocks, the beta estimate increases.

Wong used the Fama and MacBeth (1973) approach to estimate how well firm size and beta explain future returns in four periods. She reports weak empirical results for both the industrial and utility sectors. In every one of the statistical results reported for utilities, the coefficient for the size effect has a negative sign as would be expected if there is a size effect in the utility industry but only one of the results was found to be statistically significant at the 5% level. With the industrial sector, though she found two cases to have a significant size effect, a negative sign for the size coefficient occurred only 75% of the time. What is puzzling is that with these weak results, Wong concludes the analysis provides support for the small firm effect for the industrial industry but no support for a small firm effect for the utility industry.

2. New evidence on risk premiums required by small utilities

Two other studies support a conclusion that small utilities are more risky than larger ones. A study made by Staff of the Water Utilities Branch of the California Public Utilities Commission Advisory and Compliance Division (CPUC Staff, 1991) used proxies for beta risk and determined small water utilities were more risky than larger water utilities. Part of the difficulty with examining the question of relative risk of utilities is that the very small utilities are not publicly-traded. This CPUC Staff study addressed that concern by computing proxies for beta risk estimated with accounting data for the period 1981–1991 for 58 water utilities. Based on that analysis, CPUC Staff concluded that smaller water utilities were more risky and required higher equity returns than larger water utilities. Following 8 days of hearings and testimony by 21 witnesses regarding this study, it was adopted by the California Public Utilities Commission in CPUC Decision 92-03-093, dated March 31, 1992.

Table 2 provides the results of another study of differences in required returns estimated from discounted cash flow ("DCF") model estimates of the costs of equity for water utilities of different sizes. The study compares average estimates of equity costs for two smaller water utilities, Dominguez Water Company and SJW Corporation, with equity cost estimates for two larger companies, California Water Service and American States Water, for the period 1987–1997. All four utilities operated primarily in the same regulatory jurisdiction during that period. Estimates of future growth are required to make DCF estimates. Gordon, Gordon, and Gould (1989) found that a consensus of analysts' forecasts of earnings per share for the next 5 years provides a more accurate estimate of growth required in the DCF model than three different historical measures of growth. Unfortunately, such analysts' forecasts are not generally available for small utilities and thus this study assumes, as was assumed by staff at the regulatory commission, that investors relied upon past measures of growth to forecast the future. The results in Table 2 show that the smaller water utilities had a cost of equity that, on average, was 99 basis points higher than the average cost of equity for the larger water utilities. This result is statistically significant at the 90% level. In terms of the issues being addressed by Wong, the 99 basis points could be the result of differences in beta risk, the small firm effect or some combination of the two.

Table 2
Small firm equity cost differential: case study based on a comparison of DCF equity cost estimates for larger and smaller California water utilities (1987–1997)

	Larger water utilities[a]			Smaller water utilities[b]			Smaller utilities minus larger utilities
	D_0/P_0 (%)	Estimated growth (%)[c]	Equity cost estimate (%)[d]	D_0/P_0 (%)	Estimated growth (%)[c]	Equity cost estimate (%)[d]	
1987	6.60	7.17	14.24	5.38	10.06	15.98	1.74
1988	6.75	6.30	13.48	5.81	9.08	15.42	1.94
1989	7.10	6.30	13.84	6.47	7.00	13.93	0.09
1990	7.24	6.19	13.87	6.96	7.51	14.99	1.11
1991	6.94	6.29	13.67	6.64	6.24	13.30	−0.36
1992	6.18	5.96	12.50	6.50	6.71	13.65	1.14
1993	5.32	5.68	11.30	5.49	6.31	12.15	0.85
1994	6.03	4.40	10.70	5.80	4.86	10.94	0.25
1995	6.44	3.86	10.55	6.44	4.88	11.64	1.09
1996	5.60	4.06	9.88	5.77	5.58	11.67	1.79
1997	4.93	3.31	8.40	4.52	4.89	9.64	1.23
Averarage difference							0.99
t-statistic							1.405[e]

Limited to period for which Dominguez Water Company data were available. 1998 excluded due to pending buyout.

[a] American States Water and California Water Service.

[b] Dominguez Water Company and SJW Corporation.

[c] Average of 5- and 10-year dividends per share growth, 10-year earnings per share growth and estimates of sustainable growth from internal and external sources for the most recent 10-year period when data are available (1991–1997), otherwise most recent 5-year period (1987–1990).

[d] DCF equity cost as computed by California PUC staff: $k = (D_0/P_0) \times (1 + g) + g$.

[e] Significant at the 90% level.

3. Concluding remarks

Wong's concluding remarks should be re-examined and placed in perspective. She noted that industrial betas tend to decrease with increases in firm size but the same relationship is not found in every period for utilities. Had longer time intervals been used to estimated betas, as was done in Table 1, she may have found the same inverse relationship between size and beta risk for utilities in other periods. She also concludes "there is some weak evidence that firm size is a missing factor from the CAPM for the industrial but not the utility stocks" (Wong, 1993, p. 98), but the weak evidence provides little support for a small firm effect existing or not existing in either the industrial or utility sector. Two other studies discussed here support a conclusion that smaller water utility stocks are more risky than larger ones. To the extent that water utilities are representative of all utilities, there is support for smaller utilities being more risky than larger ones.

Notes

1. Vice President.
2. The small firm effect could also be a proxy for numerous other omitted risk differences between large and small utilities. An obvious candidate is differentials in access to financial markets created by size. Some very small utilities are unable to borrow money without backing of the owner. Other small utilities are limited to private placements of debt and have no access to the more liquid financial markets available to larger utilities.

References

Barry, C. B., & Brown, S. J. (1984). Differential information and the small firm effect. *Journal of Financial Economics*, 283–294.

Brauer, G. A. (1986, December). Using jump-diffusion return models to measure differential information by firm size. *Journal of Financial and Quantitative Analysis*, 447–458.

Fama, E. F., & MacBeth, J. D. (1973, May/June). Risk return and equilibrium: Empirical tests. *Journal of Political Economy*, 607–636.

Gordon, D. A., Gordon, M. J., & Gould, L. I. (1989, Spring). Choice among methods of estimating share yield. *Journal of Portfolio Management*, 50–55.

Ibbotson Associates. (2002). *Stocks, bonds, bills and inflation valuation edition 2002 yearbook*. Chicago, IL.

Roll, R. (1980, October). *A possible explanation of the small firm effect*. Unpublished manuscript, University of California, Los Angeles.

Staff of the Water Utilities Branch of the California Public Utilities Commission Advisory and Compliance Division. (1991, June 10). *Staff report on issues related to small water utilities phase one*. Commission Advisory and Compliance Division Water Utilities Branch California Public Utilities Commission, Proceeding No. I-909-11-033.

Value Line. (2000, December 29). *The Value Line investment survey—expanded edition*. Summary & Index.

Wong, A. (1993). Utility stocks and the size effect: An empirical analysis. *Journal of the Midwest Finance Association*, 95–101.

Introduction to Statistics

William Mendenhall

University of Florida

Wadsworth Publishing Company, Inc.
Belmont, California

Fifth printing: April 1966

L.C. Cat. Card No.: 63 - 18328
Printed in the United States of America

Introduction to Statistic
survey course in statistic
mathematical backgrounc
some of the uses of statisti
The need for interesti
is obvious when one consic
in the application of the s
attempt to fill this need ar
matical and rigorous pr
approach. I believe that
both of these extremes. Fo
elementary and readable
inference. The book expl
and where it fits into the
proof or intuitive justificat
The theory of probal
presented in an elementar
student employs probabilit
for simple discrete randon
distributions and empirica
the concept of a statistical
beginner to learn, I have
period of time. Specifical
an early stage in introdu
associated with sampling
reader is led through the r
hypothesis in Chapter 6, an
portions of the text until it

Thus, we estimate the difference in mean time to assemble, $\mu_1 - \mu_2$, to fall in the interval -1.02 to 8.34. Note that the interval width is considerable and that it would seem advisable to increase the size of the samples and re-estimate.

Before concluding our discussion it is necessary to comment on the two assumptions upon which our inferential procedures are based. Moderate departures from the assumption that the populations possess a normal probability distribution do not seriously affect the distribution of the test statistic and the confidence coefficient for the corresponding confidence interval. On the other hand, the population variances should be nearly equal in order that the aforementioned procedures be valid.

If there is reason to believe that the population variances are unequal, an adjustment must be made in the test procedure and the corresponding confidence interval. We omit a discussion of these techniques but refer the interested reader to texts by Li or Anderson and Bancroft.

A procedure will be presented in Section 9.7 for testing an hypothesis concerning the equality of two population variances.

9.5 A Paired Difference Test

A manufacturer wished to compare the wearing qualities of two different types of automobile tires, A and B. To make the comparison, a tire of type A and one of type B were randomly assigned and mounted on the rear wheels of each of five automobiles. The automobiles were then operated for a specified number of miles and the amount of wear was recorded for each tire. These measurements appear in Table 9.3. Do the data present sufficient evidence to indicate a difference in the average wear for the two tire types?

Table 9.3

AUTOMOBILE	A	B
1	10.6	10.2
2	9.8	9.4
3	12.3	11.8
4	9.7	9.1
5	8.8	8.3
	$\bar{x}_1 = 10.24$	$\bar{x}_2 = 9.76$

Analyzing tl
sample means is (
the variability oi
involved. At fir
indicate a differ
which we may cl
The pooled

$$s^2 = \frac{\sum_{i=1}^{n_1} (x_i -}{}$$

and

The calculated v

t

a value that is n
$\mu_1 = \mu_2$.
The correspc

$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2}s$

or -1.45 to 2.41
the small differen
A second gla
this conclusion.
is larger than the
automobiles. Th
below.

assemble, $\mu_1 - \mu_2$,
he interval width is
to increase the size of

ary to comment on
procedures are based.
the populations possess
ffect the distribution
or the corresponding
population variances
tioned procedures be

pulation variances are
test procedure and the
discussion of these
ts by Li or Anderson

9.7 for testing an
ation variances.

vearing qualities of two
make the comparison,
assigned and mounted
The automobiles were
and the amount of wear
s appear in Table 9.3.
ate a difference in the

B
10.2
9.4
11.8
9.1
8.3
$\bar{x}_2 = 9.76$

Exhibit TMZ-R5
Page 4 of 7

Analyzing the data, we note that the difference between the two sample means is $(\bar{x}_1 - \bar{x}_2) = .48$, a rather small quantity, considering the variability of the data and the small number of measurements involved. At first glance it would seem that there is little evidence to indicate a difference between the population means, a conjecture which we may check by the method outlined in Section 9.3.

The pooled estimate of the common variance, σ^2, is

$$s^2 = \frac{\sum_{i=1}^{n_1} (x_i - \bar{x}_1)^2 + \sum_{i=1}^{n_2} (x_i - \bar{x}_2)^2}{n_1 + n_2 - 2} = \frac{6.932 + 7.052}{5 + 5 - 2} = 1.748,$$

and

$$s = 1.32.$$

The calculated value of t used to test the hypothesis that $\mu_1 = \mu_2$ is

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{s\sqrt{\frac{1}{n} + \frac{1}{n}}} = \frac{10.24 - 9.76}{1.32\sqrt{\frac{1}{5} + \frac{1}{5}}} = .58,$$

a value that is not nearly large enough to reject the hypothesis that $\mu_1 = \mu_2$.

The corresponding 95% confidence interval is

$$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2} s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}} = (10.24 - 9.76) \pm (2.306)(1.32)\sqrt{\frac{1}{5} + \frac{1}{5}}$$

or -1.45 to 2.41. Note that the interval is quite wide, considering the small difference between the sample means.

A second glance at the data reveals a marked inconsistency with this conclusion. We note that the wear measurement for the type A is larger than the corresponding value for type B for *each* of the five automobiles. These differences, recorded as $d = A - B$, are shown below.

AUTOMOBILE	$d = A - B$
1	.4
2	.4
3	.5
4	.6
5	.5
	$\bar{d} = .48$

Suppose that we were to use x, the number of times that A is larger than B, as a test statistic, as was done in Exercise 21, Chapter 6. Then the probability that A would be larger than B on a given automobile, assuming no difference between the wearing quality of the tires, would be $p = 1/2$, and x would be a binomial random variable.

If we choose $x = 0$ and $x = 5$ as the rejection region for a two-tailed test, then $\alpha = P(0) + P(5) = 2(1/2)^5 = 1/16$. We would then *reject* H_0: $\mu_1 = \mu_2$ with a probability of a type I error equal to $\alpha = 1/16$. Certainly this is evidence to indicate that a difference exists in the mean wear of the two tire types.

The reader will note that we have employed two different statistical tests to test the same hypothesis. Is it not peculiar that the t-test, which utilizes more information (the actual sample measurements) than the binomial test, fails to supply sufficient evidence for rejection of the hypothesis $\mu_1 = \mu_2$?

The explanation of this seeming inconsistency is quite simple. The t-test described in Section 9.3 is *not* the proper statistical test to be used for our example. The statistical test procedure, Section 9.3, required that the two samples be *independent* and random. Certainly, the independence requirement was violated by the manner in which the experiment was conducted. The (pair of) measurements, an A and a B, for a particular automobile are definitely related. A glance at the data will show that the readings are of approximately the same magnitude for a particular automobile but vary from one automobile to another. This, of course, is exactly what we might expect. Tire wear, in a large part, is determined by driver habits, the balance of the wheels, and the road surface. Since each automobile had a different driver, we would expect a large amount of variability in the data from one automobile to another.

The familiarity we have gained with interval estimation has shown that the width of the large and small sample confidence intervals will depend upon the magnitude of the standard deviation of the point estimator of the parameter. The smaller its value, the better the estimate and the more likely that the test statistic will reject the null hypothesis if it is, in fact, false. Knowledge of this phenomenon was utilized in *designing* the tire wear experiment.

The experimenter would realize that the wear measurements would vary greatly from auto to auto and that this variability could not be separated from the data if the tires were assigned to the ten wheels in a *random* manner. (A random assignment of the tires would have implied that the data be analyzed according to the procedure of Section 9.3.) Instead, a comparison of the wear between the tire

types A and B mad
measurements. T
variability and yie
wearing quality fo
The proper a
measurements to
equal to zero, a st
The reader m
the five difference

Then,

and

The critical v
four degrees of fre
$t = 12.8$ is extrem
conclude that the
that for type A.
A 95% confic
wear would be

$\bar{d}$:

or $.48 \pm .10$.
The statistica
example of a *rand*
often called a *paire*
occurred when the
collected. Comp
homogeneous bloc
to the two automo
An indication
by blocking the ti
calculated confid
analysis with the i
The confidence int

types A and B made on each automobile resulted in the five difference measurements. This design eliminates the effect of the car-to-car variability and yields more information on the mean difference in the wearing quality for the two tire types.

The proper analysis of the data would utilize the five difference measurements to test the hypothesis that the average difference is equal to zero, a statement which is equivalent to $H_0\colon \mu_1 = \mu_2$.

The reader may verify that the average and standard deviation of the five difference measurements are

$$\bar{d} = .48,$$

$$s_d = .0837.$$

Then,

$$H_0\colon \mu_d = 0$$

and

$$t = \frac{\bar{d} - 0}{s_d/\sqrt{n}} = \frac{.48}{.0837/\sqrt{5}} = 12.8.$$

The critical value of t for a two-tailed statistical test, $\alpha = .05$ and four degrees of freedom, is 2.776. Certainly, the observed value of $t = 12.8$ is extremely large and highly significant. Hence we would conclude that the average amount of wear for tire type B is less than that for type A.

A 95% confidence interval for the difference between the mean wear would be

$$\bar{d} \pm t_{\alpha/2} s_d/\sqrt{n} = .48 \pm (2.776)\frac{(.0837)}{\sqrt{5}}$$

or $.48 \pm .10$.

The statistical design of the tire experiment represents a simple example of a *randomized block design* and the resulting statistical test is often called a *paired difference* test. The reader will note that the pairing occurred when the experiment was planned and *not* after the data was collected. Comparisons of tire wear were made within relatively homogeneous blocks (automobiles) with the tire types *randomly* assigned to the two automobile wheels.

An indication of the gain in the amount of information obtained by blocking the tire experiment may be observed by comparing the calculated confidence interval for the unpaired (and incorrect) analysis with the interval obtained for the paired difference analysis. The confidence interval for $(\mu_1 - \mu_2)$ that might have been calculated,

Exhibit TMZ-R5
Page 7 of 7

had the tires been randomly assigned to the ten wheels (unpaired), is unknown but likely would have been of the same magnitude as the interval -1.45 to 2.41, calculated by analyzing the observed data in an unpaired manner. Pairing the tire types on the automobiles (blocking) and the resulting analysis of the differences produced the interval estimate .38 to .58. Note the difference in the width of the intervals indicating the very sizeable increase in information obtained by blocking in this experiment.

While blocking proved to be very beneficial in the tire experiment, this may not always be the case. We observe that the degrees of freedom available for estimating σ^2 is less for the paired than for the corresponding unpaired experiment. If there were actually no difference between the blocks, the reduction in the degrees of freedom would produce a moderate increase in the $t_{\alpha/2}$ employed in the confidence interval and hence increase the width of the interval. This, of course, did not occur in the tire experiment because the large reduction in the standard deviation of $\bar{d}$ more than compensated for the loss in degrees of freedom.

9.6 Inference Concerning a Population Variance

We have seen in the preceding sections that an estimate of the population variance, σ^2, is fundamental to procedures for making inferences about population means. Moreover, there are many practical situations where σ^2 is the primary objective of an experimental investigation, thus it assumes a position of far greater importance than that of the population mean.

Scientific measuring instruments must provide unbiased readings with a very small error of measurement. An aircraft altimeter that measured the correct altitude on the *average* would be of little value if the standard deviation of the error of measurement were 5000 feet. Indeed, bias in a measuring instrument can often be corrected but the precision of the instrument, measured by the standard deviation of the error of measurement, is usually a function of the design of the instrument itself and cannot be controlled.

Machined parts in a manufactured process must be produced with minimum variability in order to reduce out-of-size and hence defective products. And, in general, it is desirable to maintain a minimum variance in the measurements of the quality characteristics of an industrial product in order to achieve process control and therefore minimize the percentage of poor quality product.